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VOCATIONAL INFORMATION SERVICE

OPPORTUNITY MONOGRAPH

VOCATIONAL REHABILITATION
SERIES NO. 29

FOR DISABLED SOLDIERS, SAILORS, AND MARINES
TO AID THEM IN CHOOSING A VOCATION

DRAFTING

MECHANICAL DRAWING
MECHANISM AND MACHINE DESIGN
TINSMITHING
SHEET-METAL DRAFTING
PATTERN DRAFTING

ARCHITECTURAL DRAFTING

HYDROGRAPHIC AND TOPOGRAPHIC DRAFTING
SHIP DRAFTING
PATENT DRAFTING
COMMERCIAL AND OTHER DRAFTING
LETTERING

PREPARED BY THE
FEDERAL BOARD FOR VOCATIONAL EDUCATION
AND ISSUED IN COOPERATION WITH THE
OFFICE OF THE SURGEON GENERAL, WAR DEPARTMENT, AND
BUREAU OF MEDICINE AND SURGERY, NAVY DEPARTMENT

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Note to the Disabled Soldier, Sailor, or Marine.

As a disabled soldier, sailor, or marine you should remember that the Office of the Surgeon General, War Department, and all its employees, the Bureau of Medicine and Surgery, Navy Department, and all its employees, and the Federal Board for Vocational Education and all its employees are mutually interested in your welfare solely. They have arranged a definite plan of cooperation to help you in every possible way. You can not afford to leave the hospital until the medical officers have done everything that they can for you to restore you to physical health and strength. Any other course will interfere with your vocational success later. Furthermore, you should by all means take advantage of the educational opportunities which the hospital has provided for you.

While you are making up your mind what line of work you want to follow you should take advantage of the opportunities to try yourself out in the different lines of activities which are provided at the hospital. When once you have made up your mind as to the employment you want to enter or the kind of training you want the Federal Board to give you after you leave the hospital, you should ask the vocational officers at the hospital to provide for you the kind of training which will advance you in the direction of the occupation which you expect to follow or for which you expect to be trained after you leave the hospital. You will find the educational officers at the hospital eager to render this service for you, and you should consult them early in your hospital career.

All disabled soldiers, sailors, and marines in hospitals who want information about reeducation should ask any instructor of the Hospital Educational Service or the representative of the Federal Board for Vocational Education.

Men discharged from the military or naval service who want information should write to or call at the office of the Federal Board for Vocational Education, Washington, D. C., or the District Office of the Federal Board of the district in which they are located. The district offices of the Board are located at the following points: Boston, New York City, Philadelphia, Washington, Atlanta, New Orleans, Dallas, St. Louis, Cincinnati, Chicago, Minneapolis, Denver, San Francisco, and Seattle. For addresses see p. 60.

Acknowledgment.

This monograph was prepared by Francis E. Alden, under the direction of Charles H. Winslow, Chief of the Research Division of the Federal Board for Vocational Education. Acknowledgment is due to Dr. John Cummings of the Research Division for editorial assistance.

DRAFTING.

Drafting is a universal language. It is the natural mother tongue of the mechanic in every country. He who has mastered this language can converse in it freely with fellow mechanics of every race and nationality—the American with the French, the Italian, the Swede, the German. It is the common language of metal workers, woodworkers, builders, designers, and architects the world over.

Can you speak this language?

Have you had training and experience in drafting or related subjects? The amount that you have had, great or small, will furnish a basis for additional training, or possibly for specialization in some particular kind of drafting work.

Remember that this monograph is written for your benefit. If you are disabled for other kinds of work, you may find somewhere in this monograph information that will lead you to a remunerative occupation. The Federal Board for Vocational Education has your interest at heart. If you have your eyes and your hands, or if you have only one eye and one hand, you may successfully train for the profession of drafting. It will develop and educate you, give you your livelihood, give you, as has been well said, a universal language understood in all countries and used in all trades, and give you an opportunity to help Uncle Sam in industry as you have helped him in war.

The Federal Board for Vocational Education wishes not only to suggest this course of study to fit the disabled soldier for lucrative employment, but to call attention to the fact that it will furnish the necessary training free of cost to him.

Perhaps no occupation presents such opportunity for individual development as that of drafting. Many and varied are the classes of work that the draftsman is called upon to perform. The engineer, architect, shipbuilder, topographer, and patent attorney make constant call upon his originality and knowledge; to them he is indispensable.

A machine or apparatus is to be manufactured, a building is to be constructed, a ship is to be built, a map is to be made, an application for letters patent is to be filed; the draftsman is first called upon to draw the details of construction and to make such illustration of the same as may be needed.

Although most of the draftsman's time is spent at the drawing table, yet his relations with the designer and workmen are of an

intimate nature. Consultation with those who have the actual production of the machine or apparatus in hand, is necessary, and this consultation will carry him to the workshop and to the yards.

The United States Government, as well as private industry, has need for draftsmen. The Coast and Geodetic Survey, the office of the Supervising Architect of the Treasury, the Quartermaster General's Office of the War Department, the Bureau of Ordnance, Docks and Yards of the Navy Department, the Fourth Assistant Postmaster General, the Light House Bureau of the Department of Commerce, the Division of Publications of the Agricultural Department, the Indian Office, the Bureau of Forestry, the Hydrographic Office of the Navy Department, the Chief of Ordnance of the War Department, and the United States Patent Office—these are a few of the Government offices in which draftsmen are employed.

The average of salaries paid by the Government to these men is $1,472 per annum. Some of them receive salaries of $3,000 per annum, the amount of salary in each case depending upon the technical character of the requirements. Private industries pay as much and more for draftsmen skilled in their particular lines.

Specialization.

The draftsman must specialize. Too much stress can not be laid upon this feature of his training. The present age is one of specialization, which is a necessary result of the growing complexity of civilized life.

The industrial field is large, and it is growing; the need for skilled draftsmen is keeping pace with that growth. More than ever at this time is America being called upon to produce. She will meet the demand. Her industrial activity must increase, and with it the demand for skilled workers must increase. For these workers the draftsman will draw intelligently and accurately the designs which they will afterwards produce.

The disabled soldier, sailor, or marine will find in the field of drawing a lucrative as well as an educational occupation. Let him take advantage of the opportunity now presented to him to get special training.

General Requirements.

A word may be said in regard to the requirements for the profession of drafting. If the disabled soldier has had previous knowledge of any of the subjects hereinafter set forth, he will, of course, find such knowledge to his advantage. There is hardly a class of work in the great field of industry where the knowledge of drawing is not of value. It may be said, indeed, that there is no industry that does not require a knowledge of drawing and the employment of draftsmen. Illustration of machine and apparatus, by the aid

of the mechanical and working drawing, is the necessary first step in the building of such machine and apparatus.

The engineer, architect, shipbuilder, machinist, sheet-metal worker, topographer, and patent attorney: all must be familiar with the subject of mechanical drawing. From the experimental data furnished by his employer, the draftsman is called upon to design and to make clear through his knowledge of the language of mechanical drawing the structure and operation of the machine or apparatus. He must be capable of visualizing to some extent the structure to be illustrated, and must then draw clearly and accurately, in order that the workman and mechanic may readily produce the complete machine or apparatus.

Too much stress can not be laid upon the usefulness of mechanical drawing and upon the necessity for a knowledge of its language in industry. More information can be imparted by the inspection of a well-executed mechanical drawing than by numberless spoken or written words.

With a knowledge of the elementary definitions of plane geometry, it is possible to understand the geometrical terms used in textbooks on mechanical drawing. As the student progresses he will be more and more interested to know the science of geometry, and he will appreciate the wide scope of its application to the solution of problems in mechanics. While no extensive knowledge of geometry is necessary for simple drafting, it is true that development of ability to handle the more complex problems in drafting involves necessarily some mastery of geometry in its practical applications. Without some elementary knowledge of geometry, mechanical drawing certainly could not be studied to advantage.

The Language of Mechanical Drawing.

The subject of mechanical drawing is of great interest and importance to all mechanics and engineers. The working drawing takes the place of lengthy explanations, either written or verbal. The better and more clearly the drawing is made the more intelligently the workman can comprehend the ideas of the designer. When it is once understood that the basis of mechanical drawing is geometric in nature, its universality is recognized; its language is understood by native and foreigner alike. Let us remember, then, that when we once understand this language we are prepared to understand mechanical drawings no matter where made. Its great scope must then appeal to one as a means of international communication in the industrial field.

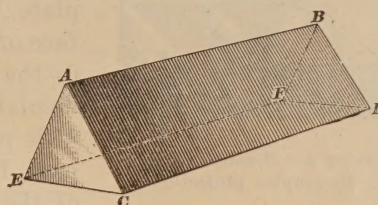


FIGURE 1.—Perspective view of triangular prism.

At first we will show the principle that underlies the art of reading a mechanical drawing and that makes of it a language by which the designer speaks to the workman, with the hope that a small view of the art will stimulate a desire to know more of it.

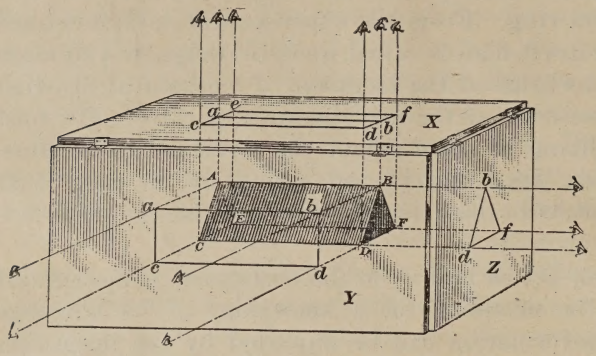


FIGURE 2.—Illustration of orthographic projection for a triangular prism.

Let us assume that a tracing of a photograph of an object has been made, and that we produce from that tracing a line drawing of the object.[1] (See fig. 1.) We then have what is called a perspective view of the object. We see that the edges *AB*, *EF*, and *CD* are parallel, that the ends *AEC* and *BFD* are triangular in contour, and that the sides of these triangles are of equal length; but if we measure them carefully we find that *AB* is not parallel to *EF* and *CD*, and that *AB*, *EF*, and *CD* are not of equal length. This is because the perspective drawing represents the object as it appears and not as it really is. We evidently need another kind of drawing to show its exact dimensions. Let us then surround the object by a transparent box, hinged as shown in figure 2. The top plate *X* of the box is parallel to the bottom face of the prism; the end plate *Z* is parallel to the end face of the prism and perpendicular to the top plate *X;* the side plate *Y* is perpendicular to the top plate *X*. If, now, from points at the top, end, and side of the object we draw projection lines, as shown, at right angles to the top, end, and side, respectively, letting these lines intersect the transparent plate *X* at points *cae*, *dbf*, plate *Z* at points *bdf*, and plate *Y* at points *abcd*, and if we then connect

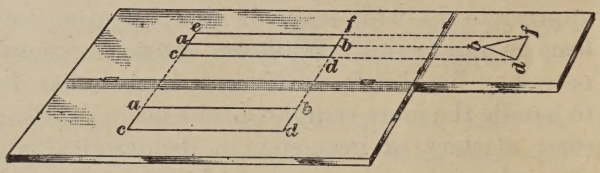


FIGURE 3.—Mechanical drawing of triangular prism.

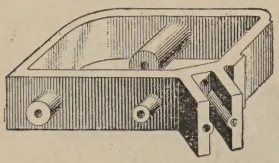


FIGURE 4.—Illustration of orthographic projection.

[1] Figures 1 to 6 are reproduced from an article by G. Herbert Follows, on "How to read a mechanical drawing." The explanation of the figures also is based upon Mr. Follows's text.

these points on the plates by lines, we shall have views of the object that will represent to the mechanic the exact dimensions and shape

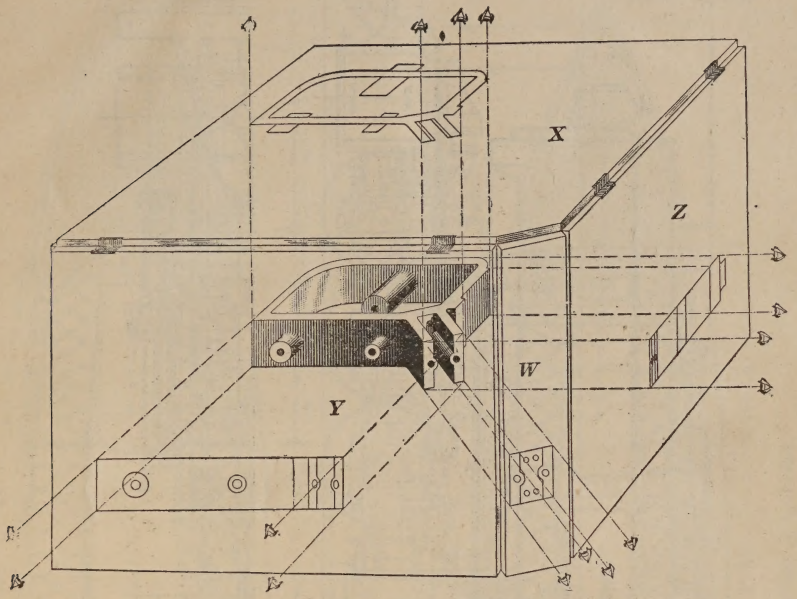


FIGURE 5.—Illustration of orthographic projection.

of the object, from which he could construct the same accurately. If, then, we revolve the plates on their hinges, as shown in figure 3, we shall have a mechanical drawing of the object. It seems simple. Yet the principle of all mechanical projection, or orthographic projection, as it is called, is here illustrated. Figures 4, 5, and 6 further illustrate the principle.

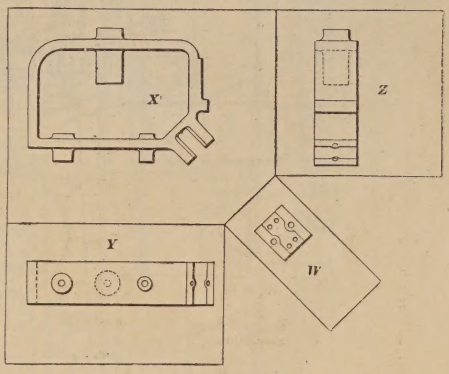


FIGURE 6.—Illustration of orthographic projection.

We have used a simple object to illustrate this principle, but, of course, objects of complex structure are constantly met with by the draftsman. Yet by keeping in mind the principle just illustrated, the draftsman is enabled to present clearly to the workman a picture of the mechanism to be constructed. More complex structures are shown by Plates I and II.

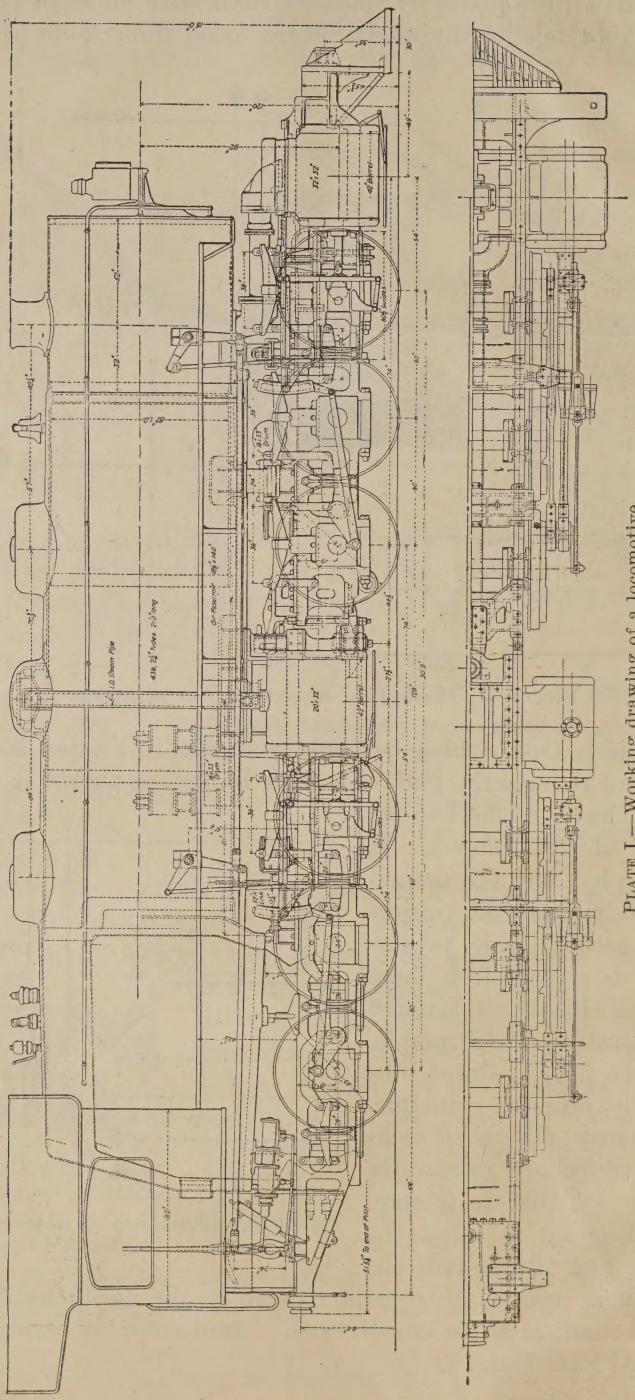
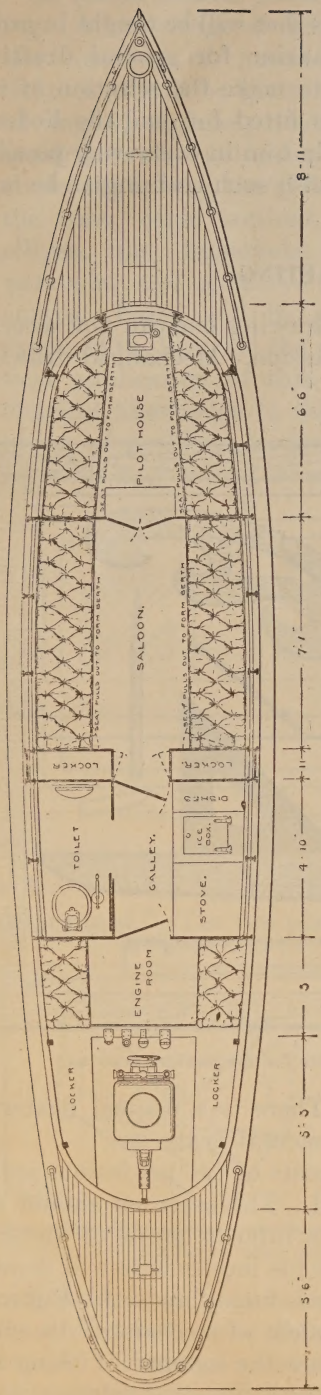


PLATE I.—Working drawing of a locomotive.



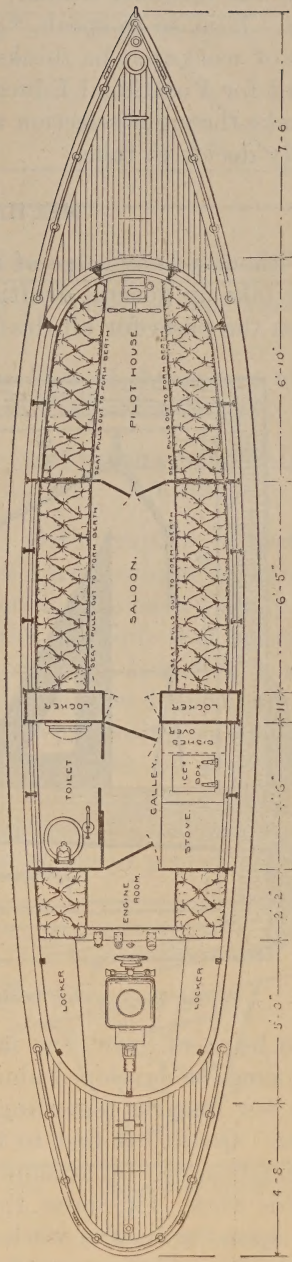


PLATE II.—Plan views of launches.

Subjects for Training.

We will now briefly outline the subjects that will be taught in order to fit the disabled soldier, sailor, or marine for general drafting work. It is, so to speak, "up to him" to make the selection of the class of work that he thinks himself best fitted for, and the Federal Board for Vocational Education will help him in every way possible to make the right selection and will furnish such training as he may finally decide to take.

MECHANICAL DRAFTING.

Without a knowledge of mechanical drawing one can not successfully take up general drafting as a profession. Mechanical drawing forms the basis for all drafting.

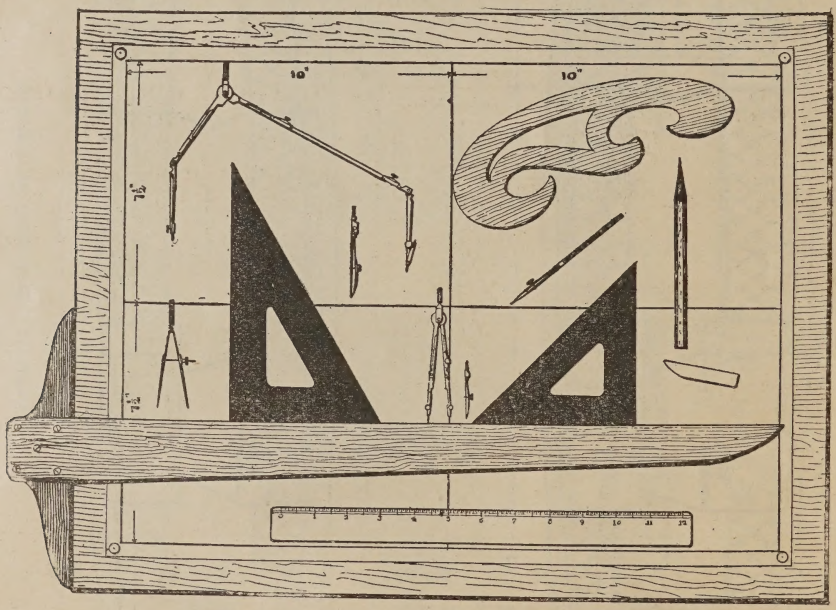


FIGURE 7.—Drawing board and instruments for mechanical drawing.

To learn to draw, one must draw. There is a manual dexterity that must be developed along with the mental dexterity.

A few remarks regarding the implements of the profession are in order. Quality is first to be considered. The beginner should not be handicapped by attempting to use an inferior grade of material for his work. Of course, the selection of his implements will depend also upon the class of work for which he is fitting himself. Figure 7 shows the implements needed for the student of mechanical drawing. Figures 8, 9, 10, and 11 show at a glance the manner of using the T-square and triangle.

As stated before, geometry forms the basis for mechanical drawing. A knowledge of the elementary definitions is essential. Under the heading of geometrical definitions will be given those of angles, surfaces, triangles, quadrilaterals, polygons, the circle, the sphere, the cylinder, the cone, conic sections, the ellipse, the hyperbola, the parabola, and adontoidal curves. Later will be given exercises to illustrate the practical application of this geometrical knowledge to the solution of problems in drafting. Some idea of the nature of these exercises may be had by an inspection of Plates III and IV.

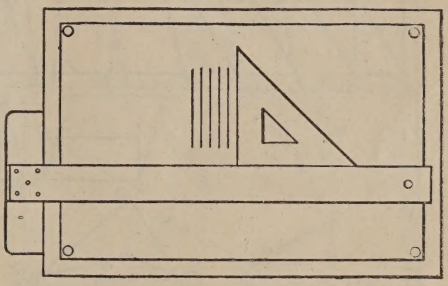


FIGURE 8.—Manner of using T-square and triangle.

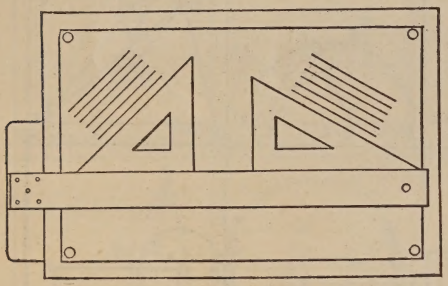


FIGURE 9.—Manner of using T-square and triangle.

ORTHOGRAPHIC PROJECTION.

Orthographic projection is the next subject to be considered. We have already shown the principle that underlies it. (See figs. 1, 2, 3, 4, 5, and 6.) It has been defined as "the art of representing objects of three dimensions, by views on two planes at right angles to each other, in such a way that their forms and positions may be completely determined." The two planes are called planes of projection, or "co-

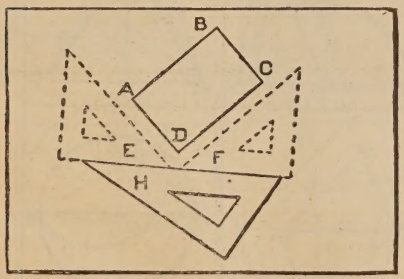


FIGURE 10.—Manner of using triangles.

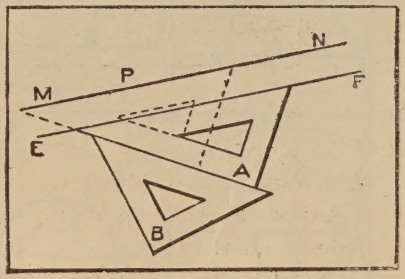


FIGURE 11.—Manner of using triangles.

ordinate planes," one being vertical and the other horizontal. (See fig. 2, in which plate *Y* is the vertical plane and plate *X* the horizontal.) Figure 12 shows orthographic projections of a wedge, a rectangular pyramid, and triangular prism, respectively.

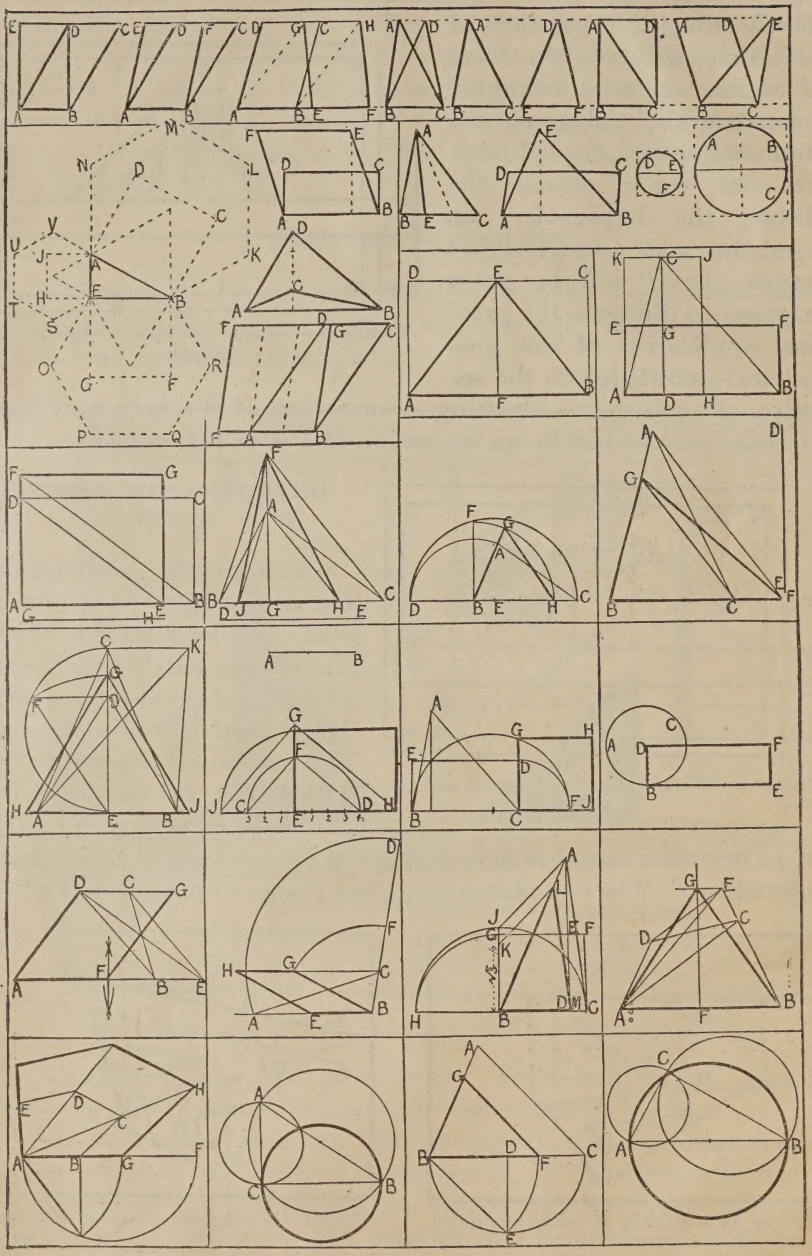


PLATE III.—Exercises in geometry. Construction of areas equal to and proportional to others.

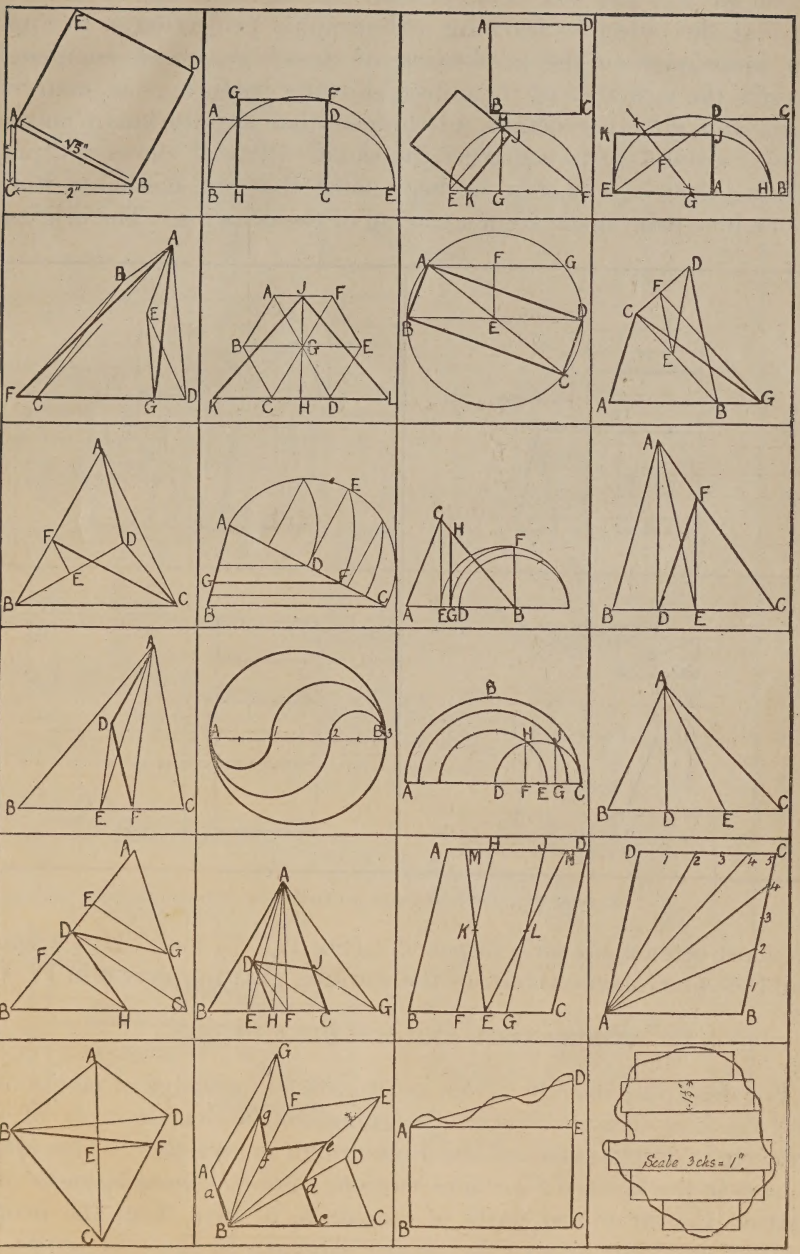


PLATE IV.—Exercises in geometry. Construction of proportional areas, division, and reduction.

After having thoroughly mastered the subject of orthographic projection we will proceed to study the working drawing, for the reason that the object in learning orthographic projection is to apply that knowledge to the production of drawings, which completely describe the structure of the object, showing its form, size, material, finish, and all other details, to the end that the workman may be enabled accurately to construct the same. Plate V shows a typical working drawing. Let it be here noted that the mechanic works from a blue print made from a tracing of the drawing. The originals

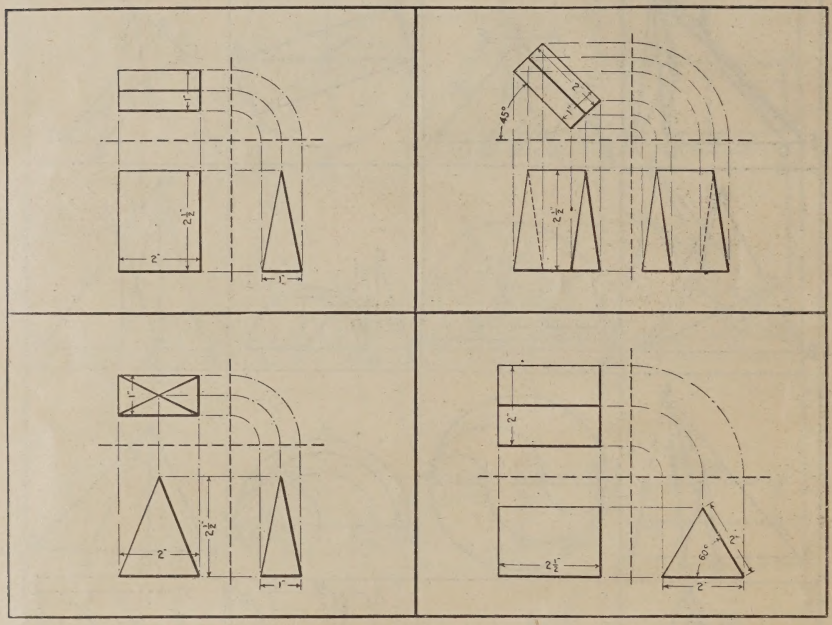


FIGURE 12.—Orthographic projection of prism.

are most often made only in pencil. (See Pls. VI and VII, a tracing and blue print, respectively, of the working drawing shown in Pl. V.)

MECHANISM AND MACHINE DESIGN.

For designing machinery one must have a knowledge of mechanism and machine design. Before designing can be done a study of the subjects of mechanism and machine design is necessary. This study relates to the laws of force and motion. One will here learn to proportion the structural parts of machines, to give them the proper motion, and also to give the proper strength to the said parts. A study of the properties of the screw, wedge, and lever, and the graphic representation of forces by the use of the "parallelogram of forces" is here necessary. The underlying principles that relate to

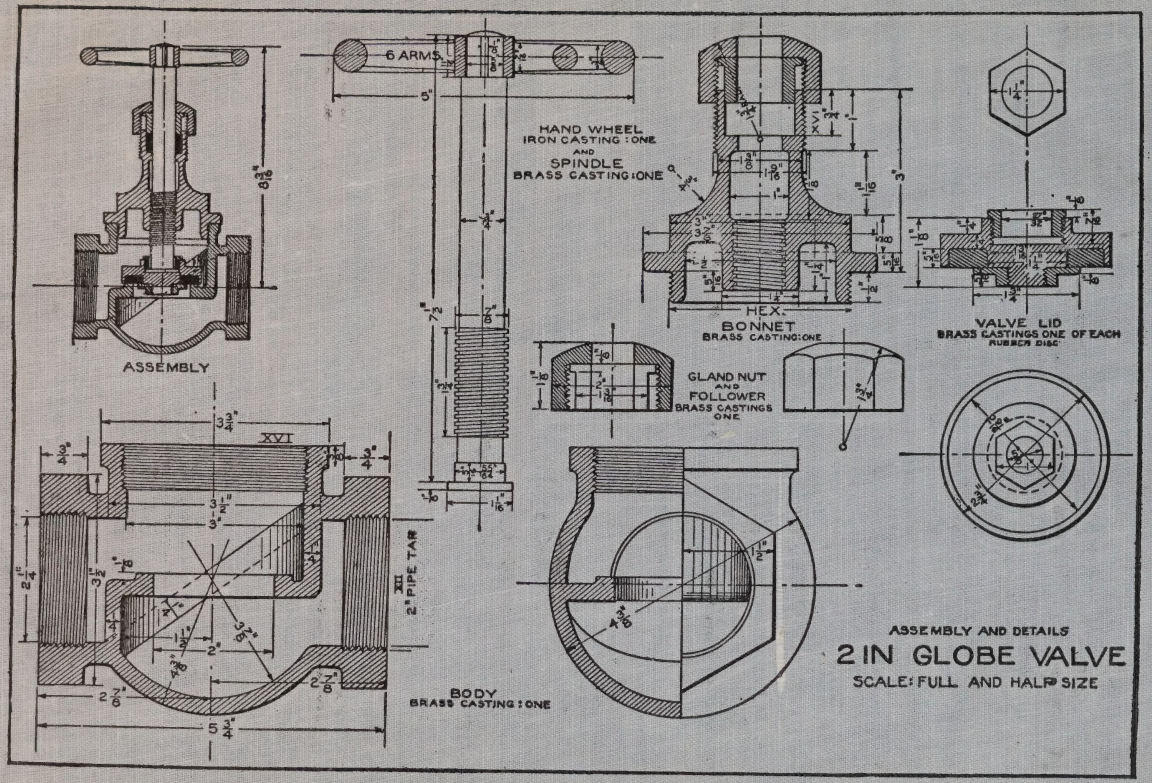
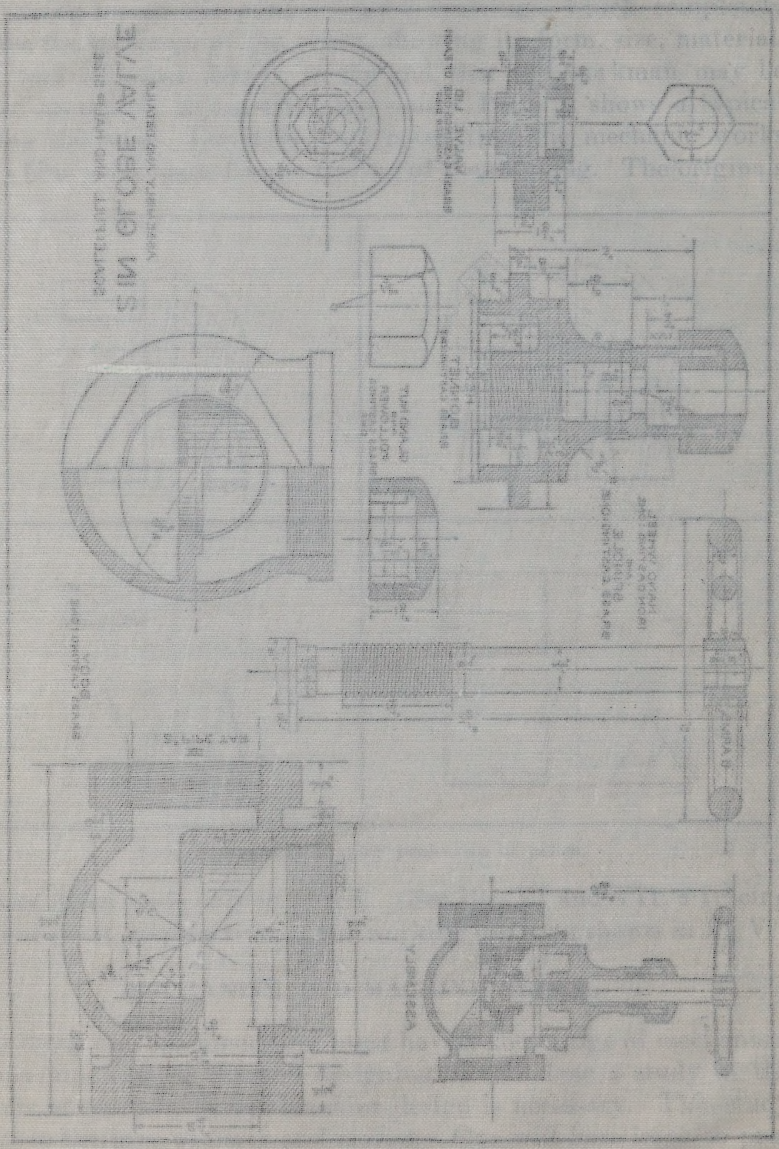


PLATE VI.—Tracing of typical working drawing.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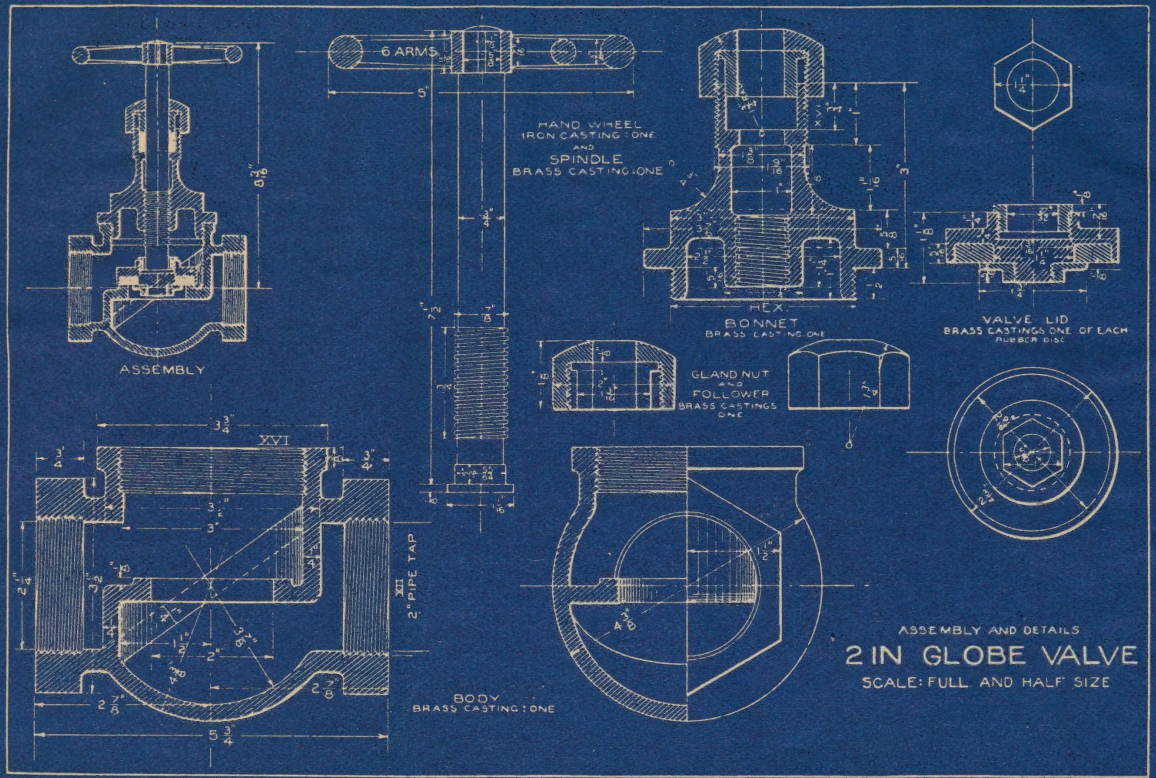


PLATE VII.—Blue print of typical working drawing.

the more common mechanical structures may be studied under the head of Physics, but they are given in textbooks on mechanism and machine design.

Much study and training is necessary to develop the ability to design machinery. A knowledge of mathematics, physics, strength of materials, and chemistry must be had.

Designers are in great demand. No illustration of this subject is given for the reason that it can not well be illustrated in a paper of this nature. The subjects will be taught in the course on mechanical drawing.

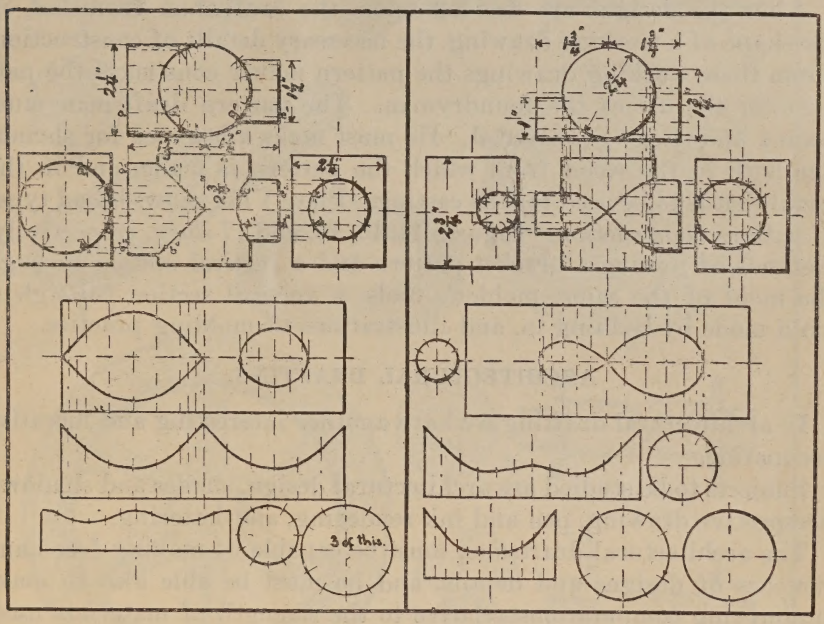


FIGURE 13.—Development.

TINSMITHING.

This class of drafting relates to the laying out of patterns for various objects to be constructed of sheet tin, such as buckets, funnels, sugar scoops, baking tins, dish pans, and the like.

The subject of intersection and development must be studied with care, because very accurate work is required. The necessity for specialization is here seen.

The general layout for a development is shown in figure 13.

SHEET-METAL DRAFTING.

Although labor-saving machinery has done much to reduce the need for great numbers of workmen in this line, yet the draftsman is as much in need as ever. Here again a knowledge of the principles

of intersection and development is required, but more careful allowance must be made for the thickness of the metal used.

Heavy structures, such as boilers, stacks, storage tanks, and ventilators are to be designed and drawn.

The subjects of tinsmithing and sheet-metal drafting are closely related.

PATTERN DRAFTING.

To mold articles of brass, cast iron, steel, and aluminum, patterns of the structures must first be made. The pattern maker is furnished with a drawing; hence the pattern draftsman.

After the designs are decided upon, the draftsman furnishes, in the shape of a working drawing, the necessary details of construction. From these working drawings the pattern maker constructs the pattern for the use of the foundryman. The pattern draftsman must have a knowledge of material. He must make allowance for shrinkage both in the wood from which the pattern is made, and in the metal that is to be used for the casting. Plate VIII shows broad types of pattern construction. Figures 14, 15, 16, and 17 show, respectively, methods of joining a bracket pattern and a vertical section through the mold of the same, molder's tools, a vertical section through a mold mode by bedding-in, and illustrations of molding practice.

ARCHITECTURAL DRAFTING.

In architectural drafting we have another interesting and lucrative occupation.

Subjects to be studied are architectural design, shades and shadows, perspective drawing, pen and ink rendering, and lettering.

The architectural draftsman must be capable of making free-hand sketches of designs and details, and he must be able also to make engineering computations relative to the strength of materials used.

Designing properly comes under the head of architecture, and to be a successful architectural draftsman one must study that subject. The designing of buildings is responsible work; a building must be constructed, keeping in mind the safety and convenience of those who will occupy it, as well as its artistic appearance.

In figure 18 we see the exterior beauty of one class of building. Artistic effect is here produced. Plate IX shows a church elevation with details of construction. Plates X and XI show, respectively, the floor plans and elevations of a frame dwelling. A knowledge of the value of shades and shadows and of the method of their determination is necessary in order to bring out more clearly the details of the scheme and of the ornamentation in the " rendering " furnished to the client by the architect. A classic study in rendering is shown by Plate XII, reproduced by permission of the Massachusetts Institute of Technology.

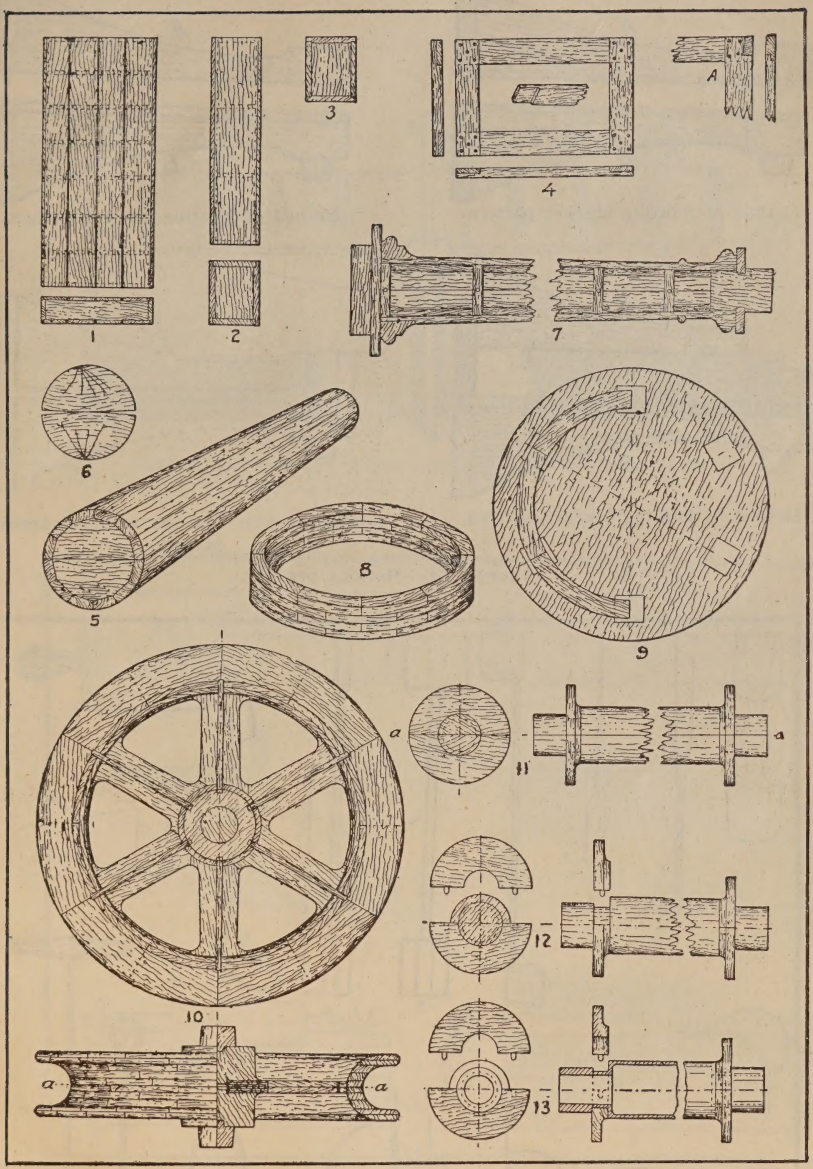
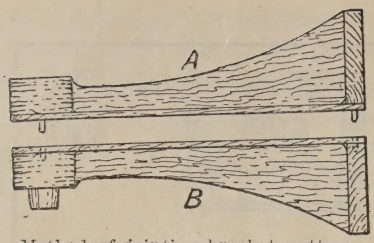
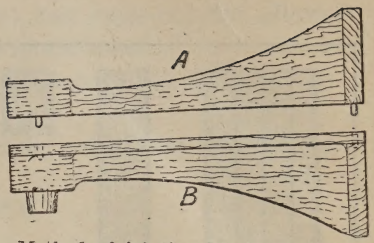


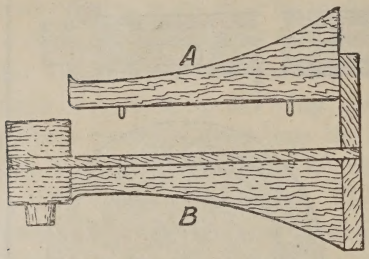
PLATE VIII.—Broad types of pattern construction: 1, Example of open joints and boxing-up; 2, boxing-up; 3, improper method of boxing-up; 4, halvings; 5, lagged-up column; 6, warping of solid timber; 7, complete pattern column lagged up, with attachments; 8, ring built in segments; 9, commencement of the work; 10, complete sheave-pulley pattern, built up in segments; 11, pipe pattern, jointed along the center; 12, unjointed pipe pattern; 13, iron pattern, unjointed.



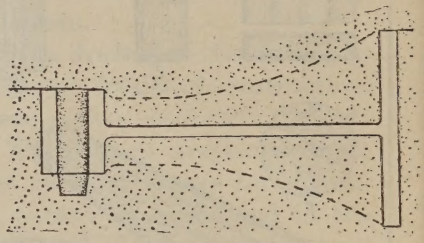
Method of jointing bracket pattern.



Method of jointing bracket pattern.



Method of jointing bracket pattern.



Vertical section through mold of bracket pattern.

FIGURE 14.—Molding practice.

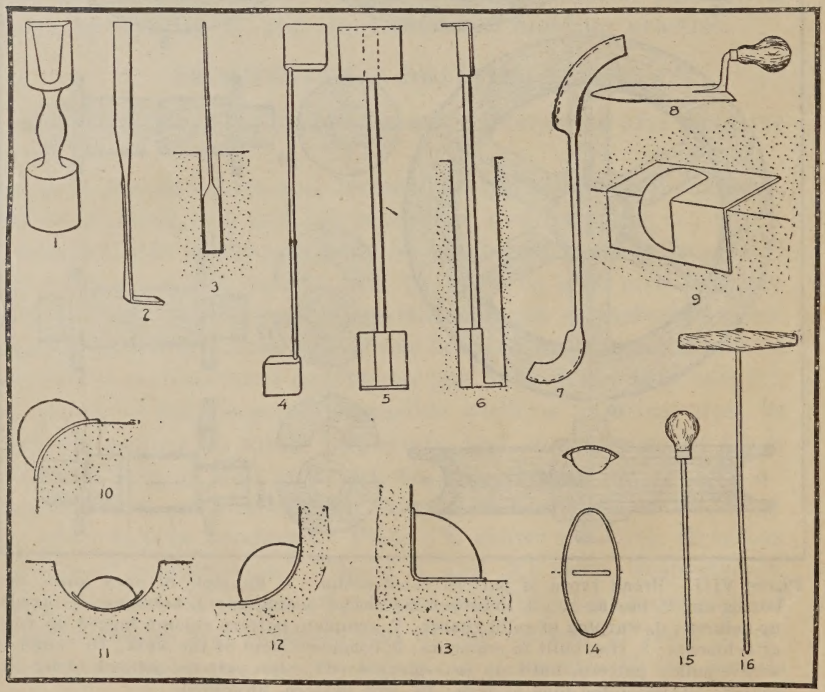


FIGURE 15.—Molder's tools: 1, small bench rammer; 2, cleaner; 3, cleaner in use; 4, another form of cleaner; 5 and 6, boss tool; 7, flange bead; 8, trowel; 9, square corner sleeker; 10, round corner sleeker; 11 and 12, pipe smoothers; 13, square corner sleeker; 14, button or bacca-box smoother; 15 and 16, vent wires.

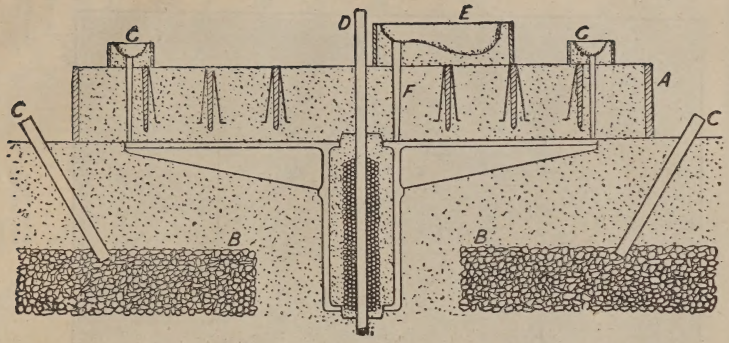


FIGURE 16.—Vertical section through mold made by bedding-in.

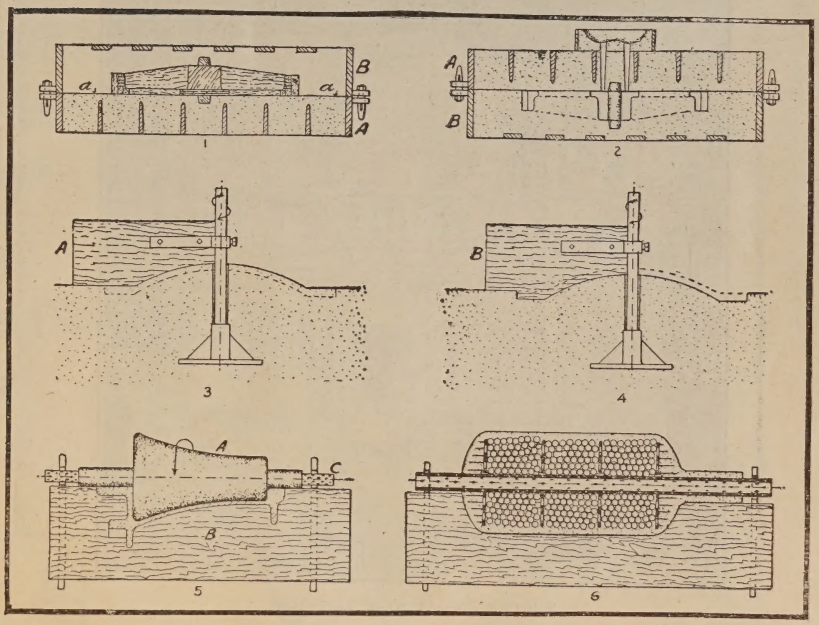


FIGURE 17.—Illustrations of molding practice: 1 and 2, two stages in mold made by turning over; 3 and 4, two views of mold made by sweeping-up; 5, sweeping up a core; 6, section through a swept-up core.

Other examples of design and rendering are shown by figures 19, 20, and 21.

To produce a picture of an object one must have a knowledge of the principles of perspective drawing. An architectural draftsman

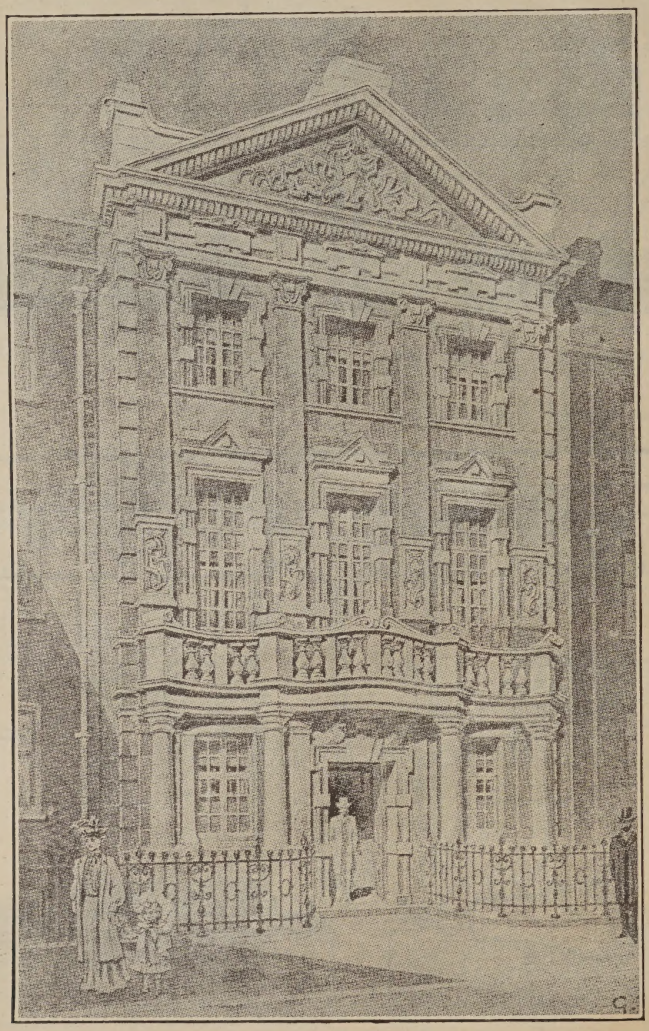


FIGURE 18.—A bank elevation.

must understand the various methods of projection used in this art. To study it one must, as in mechanical drawing, understand geometrical terms. We will only indicate in a general way, by a few illustrations, some schemes of perspective projection. (See figs. 22, 23, 24, 25, and 26.)

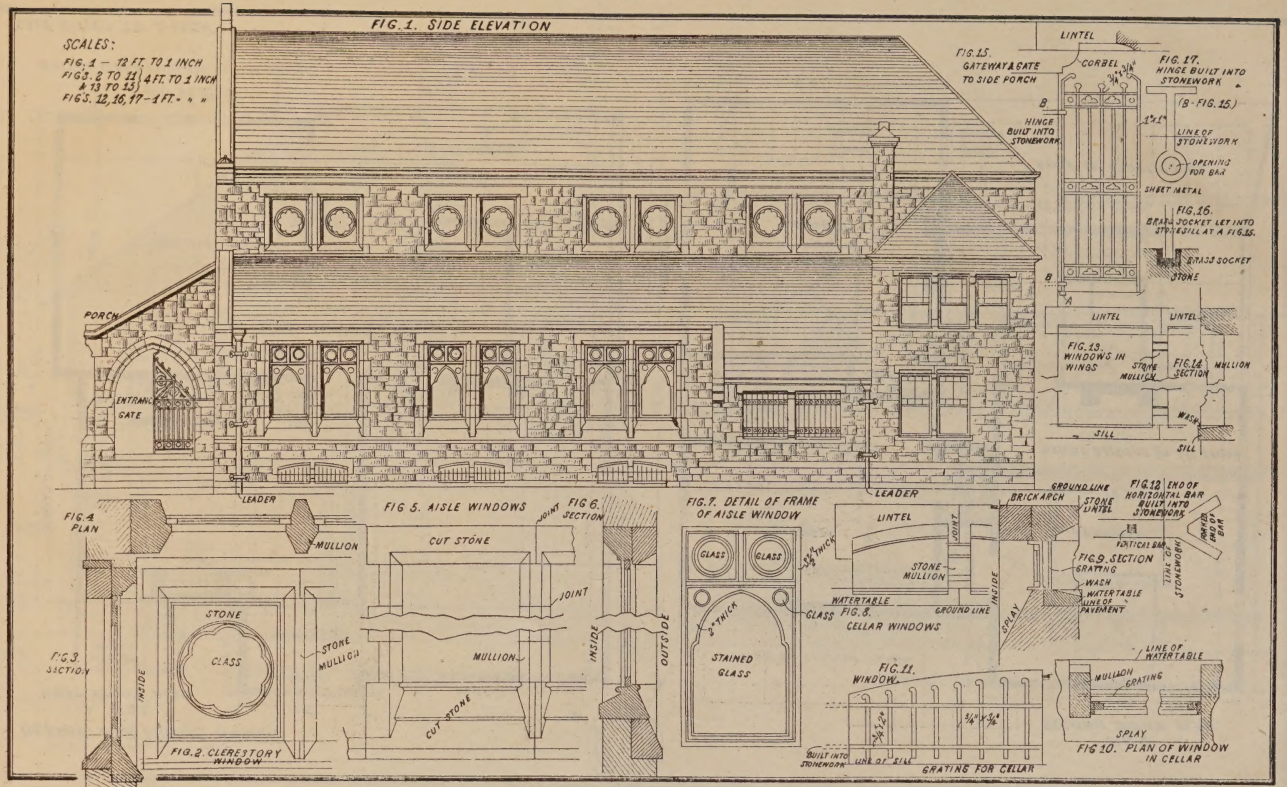


PLATE IX.—Church elevation, with details.

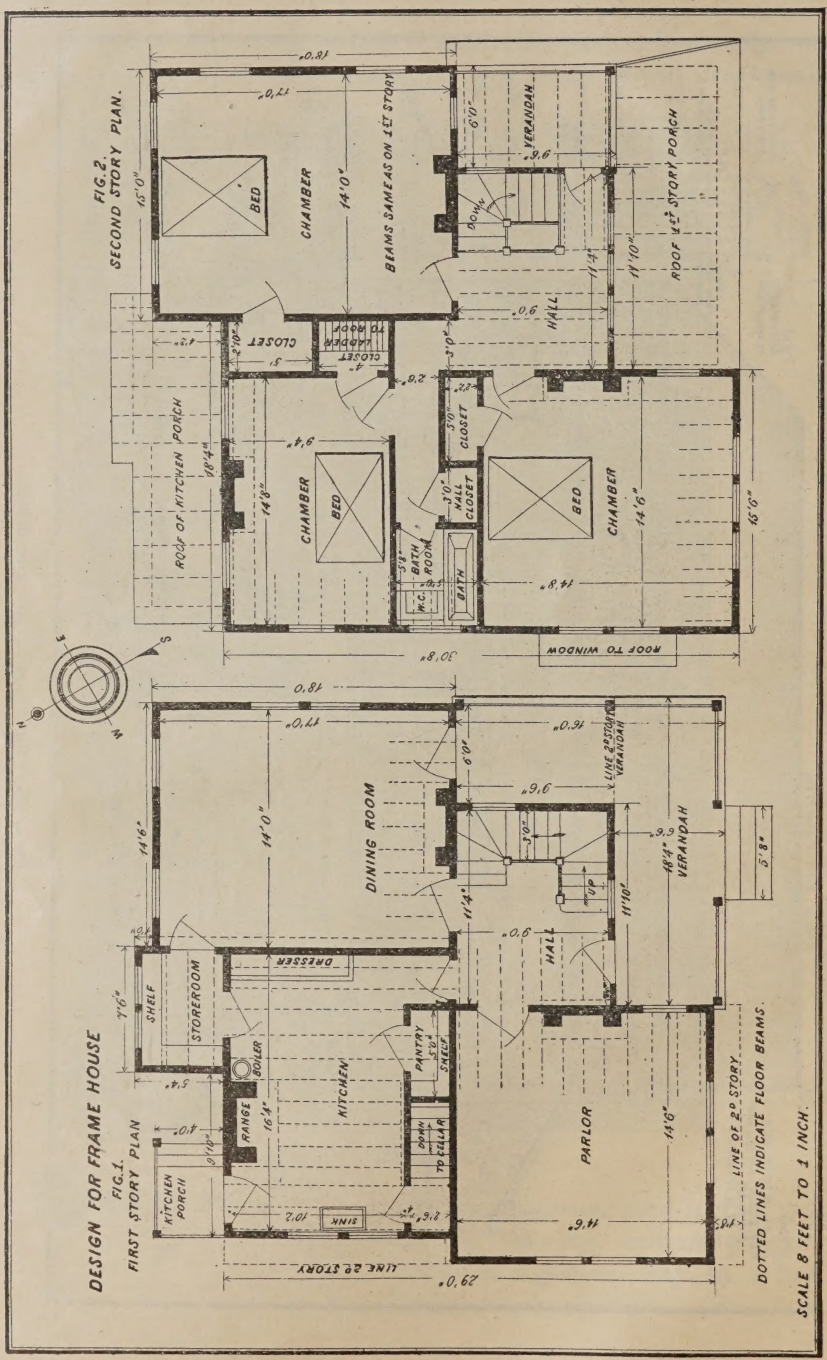


PLATE X.—Plans of frame dwelling.

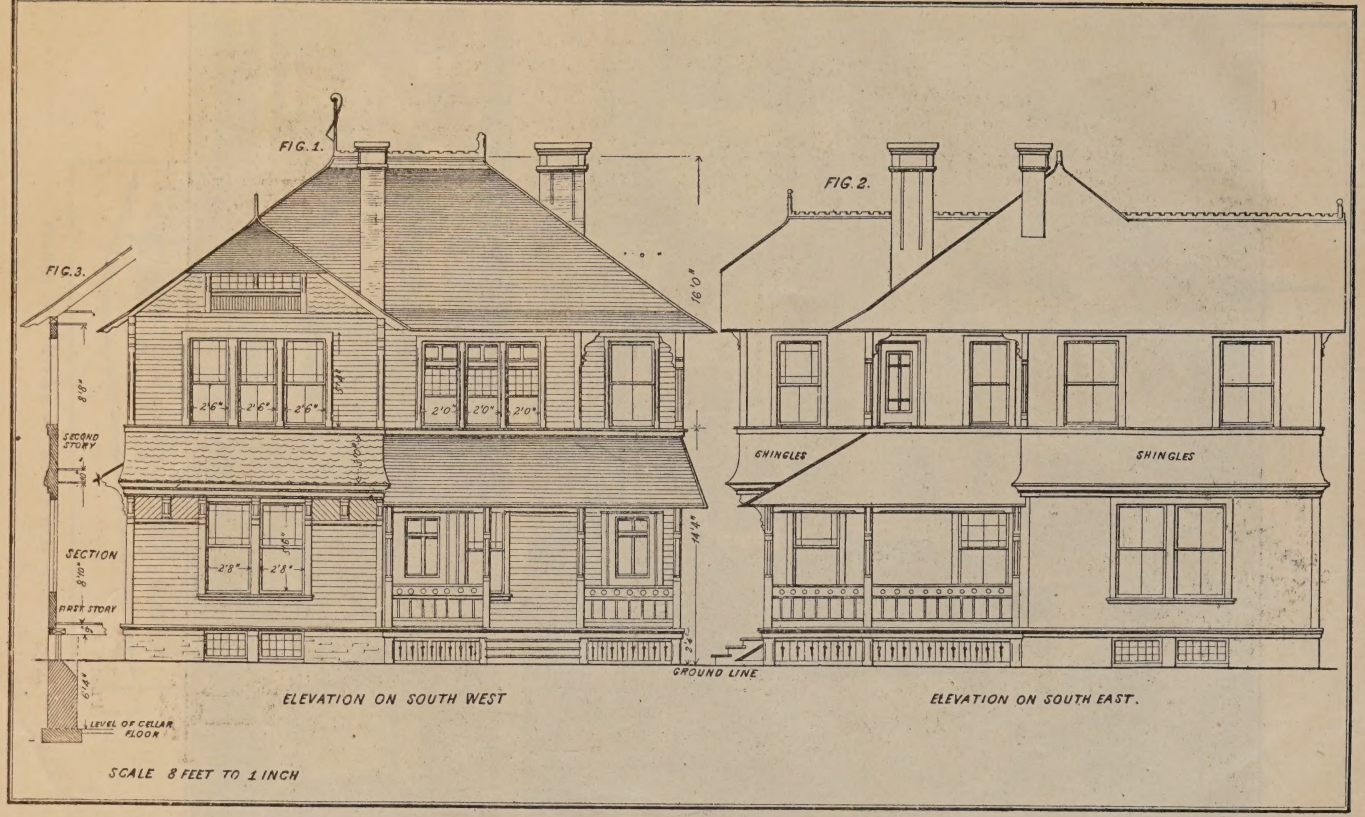


PLATE XI.—Elevations of same dwelling.

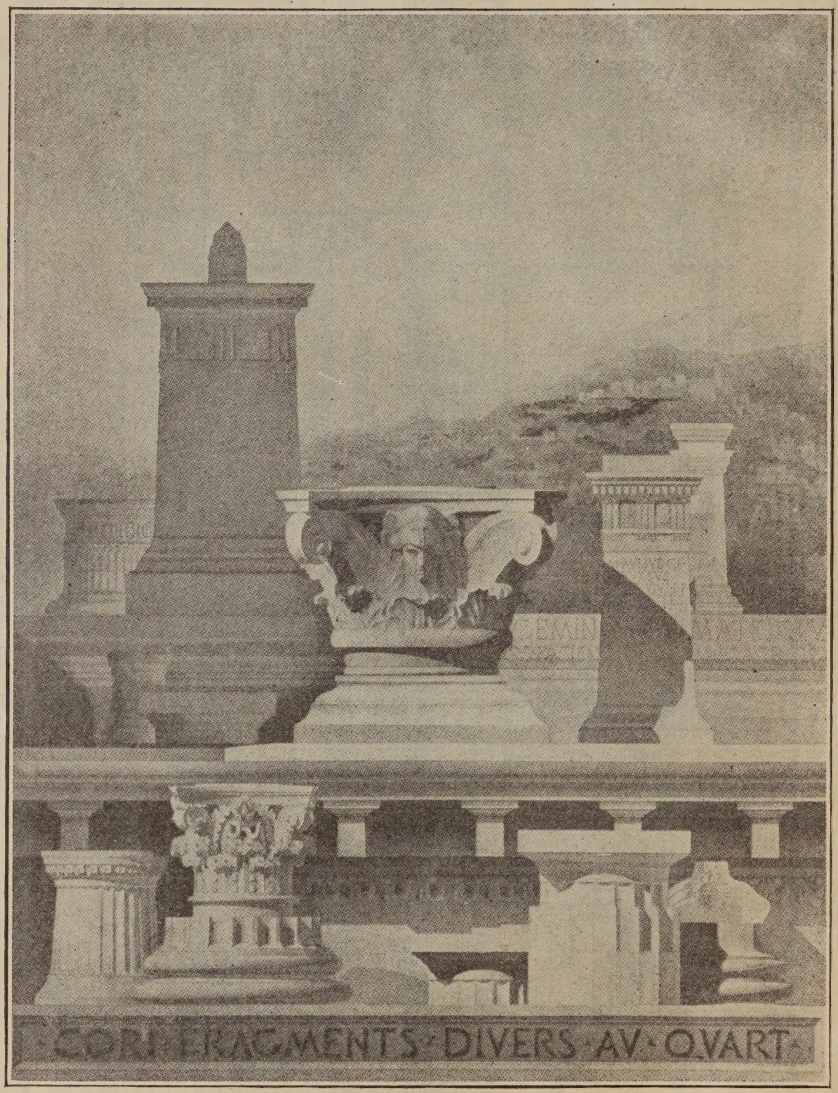


PLATE XII.—Fragments from Roman temple.

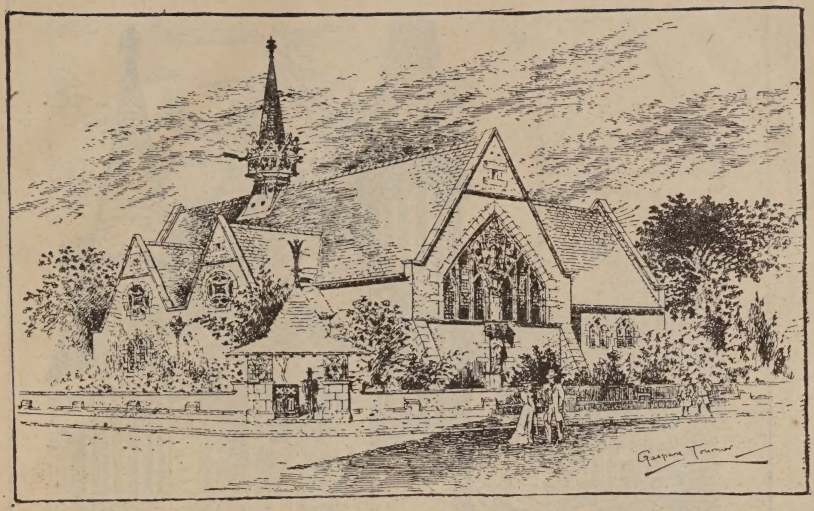


FIGURE 19.—"Quaintness" as distinguished from "dignity."

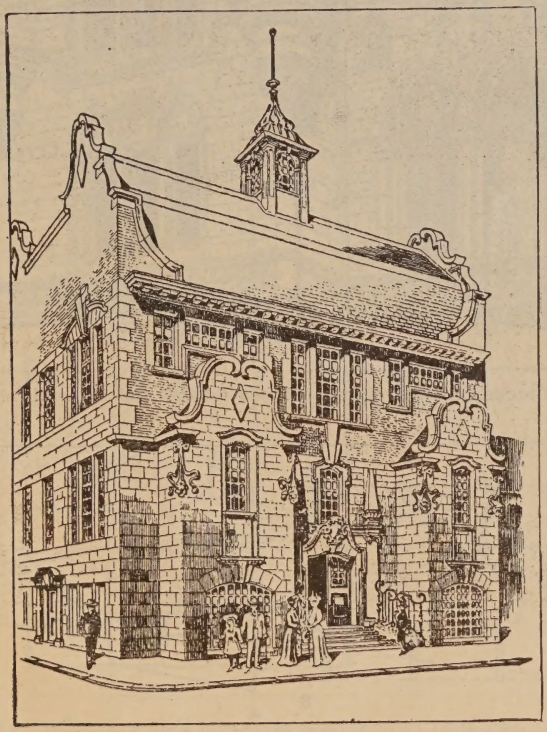


FIGURE 20.—Design for a technical school.

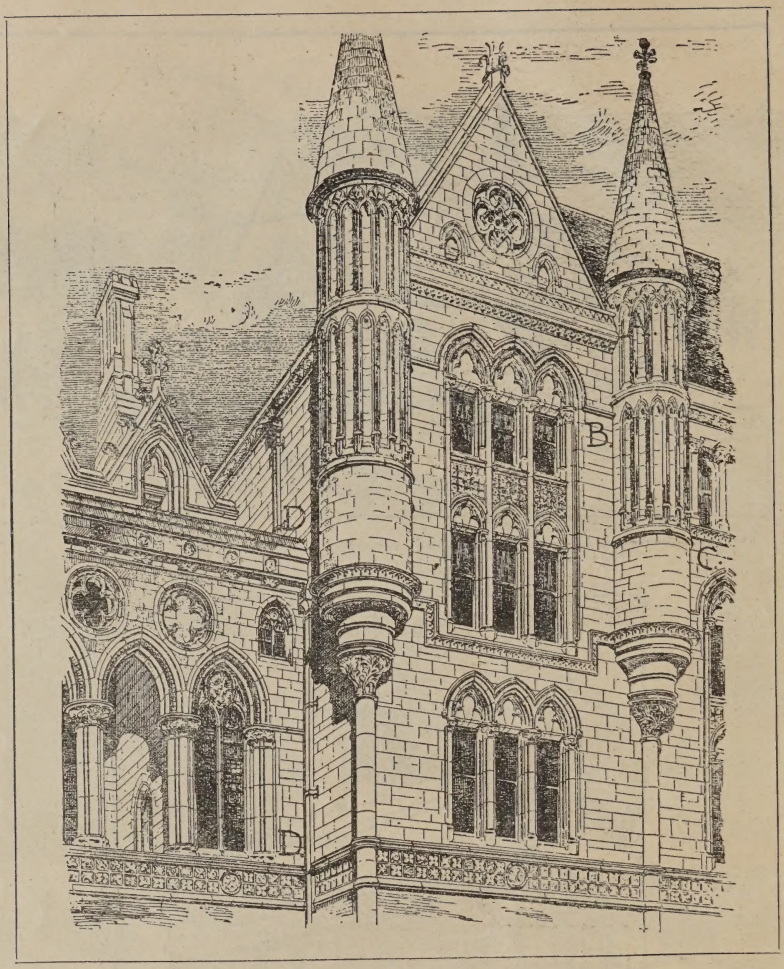


FIGURE 21.—Correlation between vertical and horizontal lines.

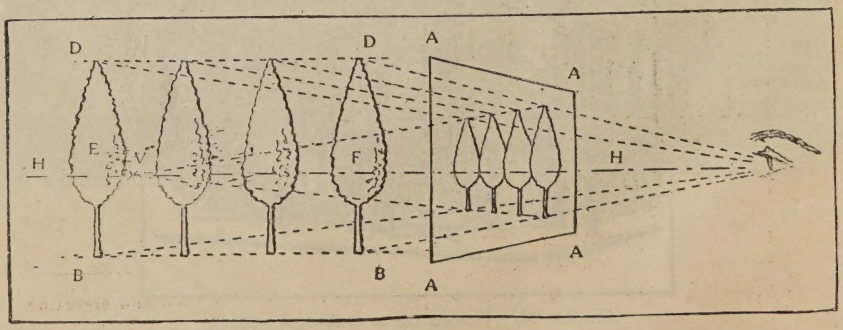


FIGURE 22.—A perspective of a row of trees seen and drawn on a glass pane.

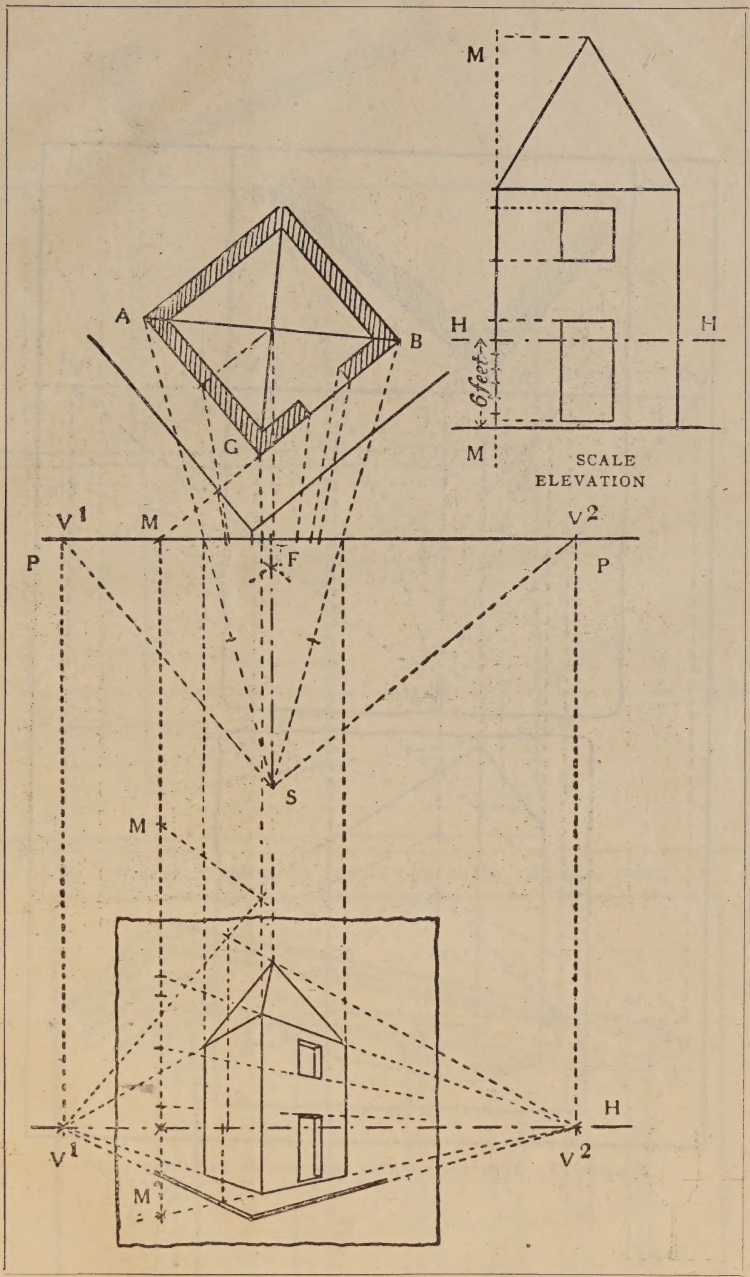


FIGURE 23.—Ordinary method of making a perspective from plan and elevation.

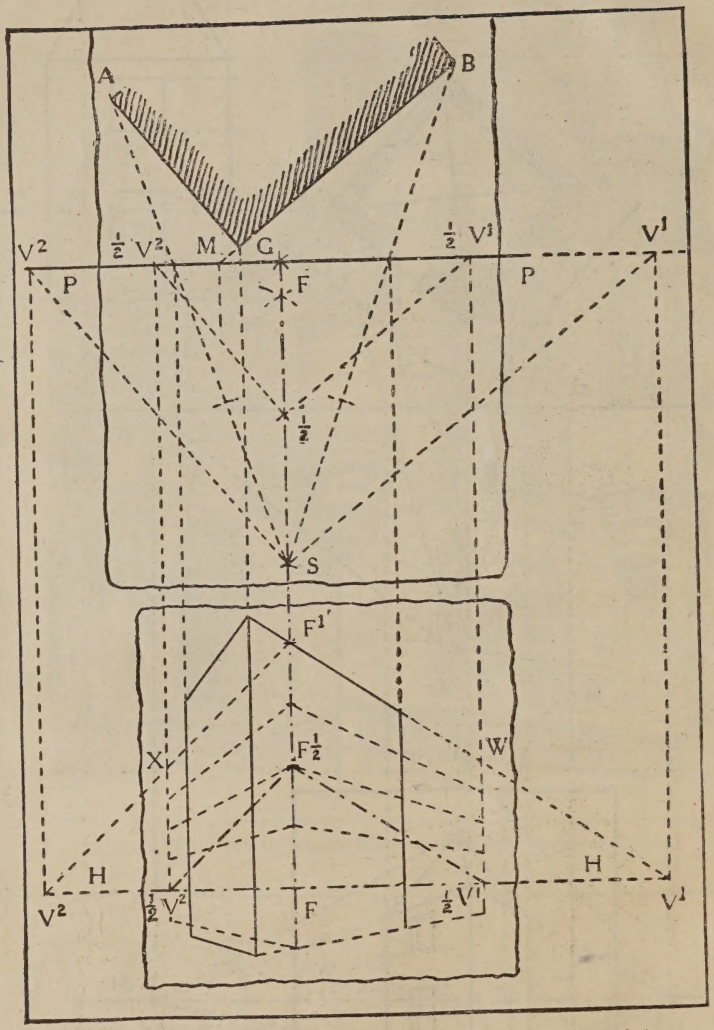


FIGURE 24.—How to find two inaccessible vanishing points.

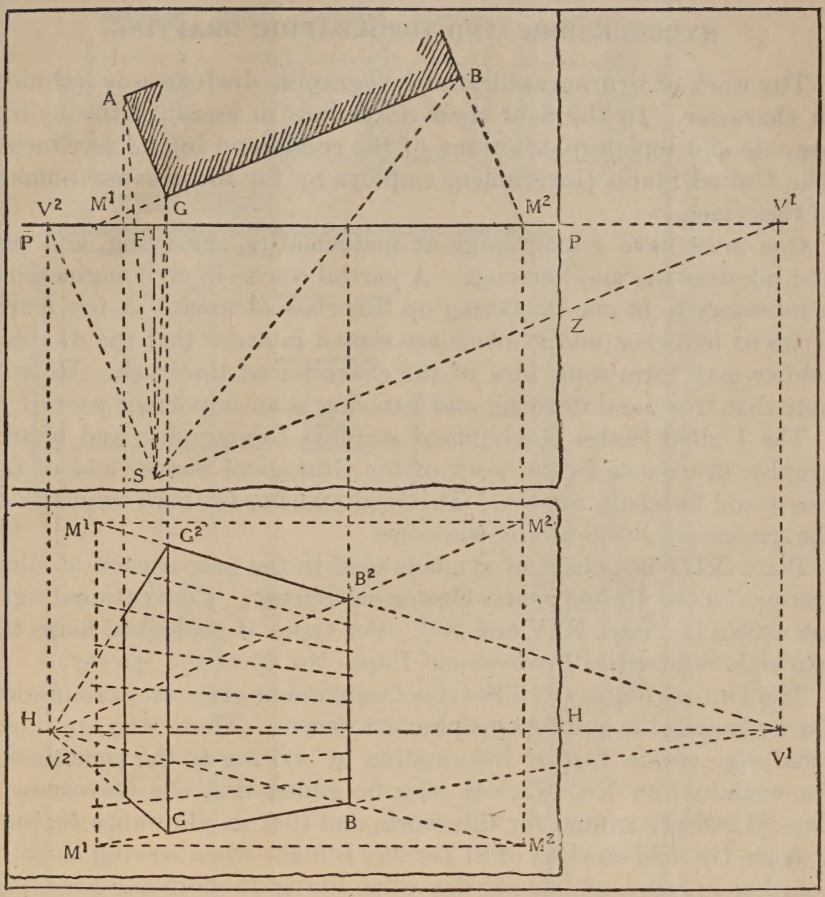


FIGURE 25.—How to find an inaccessible vanishing point.

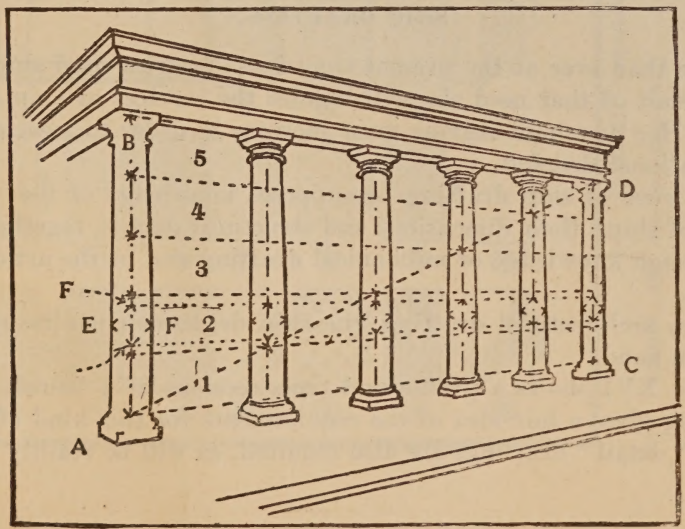


FIGURE 26.—A short method of drawing a row of columns in perspective.

HYDROGRAPHIC AND TOPOGRAPHIC DRAFTING.

The work of hydrographic and topographic draftsmen is technical in character. In the field their duties are to assist in the hydrographic and topographic survey of the coasts and inland territories. The United States Government employs by far the greatest number of these men.

One must have a knowledge of mathematics, surveying, and pen and ink drawing and lettering. A partial course in civil engineering is necessary to fit one for taking up this class of work. A few maps, styles of lettering, and symbols are shown in order that the disabled soldier may form some idea of the character of the work. He will note that free-hand drawing and lettering is an important part of it.

The United States Government employs topographic and hydrographic draftsmen in the work of the Geological Survey and of the Coast and Geodetic Survey. The requirements for both branches of the service are substantially the same.

Plate XIII is a chart of symbols used in the preparation of illustrations by the United States Geological Survey. Conventional signs are shown in Plates XIV and XV. For types of geological maps the reader is referred to Professional Paper No. 60 of the Survey.

The United States Civil Service Commission gives an examination for hydrographic and topographic draftsmen. Those who are interested may obtain further information by writing to the commission for examination No. 375. It may be added that the Government pays $1,200 per annum for this work, and that an allowance for subsistence (in field service) of $1 per day is made when serving on shipboard or in camp, and $2 per day when living on shore and boarding.

SHIP DRAFTING.

More than ever at the present time does America need ships, and as a result of that need she will require the services of ship draftsmen. Her merchant marine must increase in order to meet a great international demand.

The work of ship drafting presupposes knowledge of the various types of ships, their dimensions and structural details, together with a thorough knowledge of mechanical drafting and of the art of ship design.

As in architectural drafting, the ship draftsman has responsible work in hand.

Plate XVI shows a profile and cross sections of a launch. This drawing gives a fair idea of the requirements for this kind of work. Many " detail " drawings are also required, as will be readily understood.

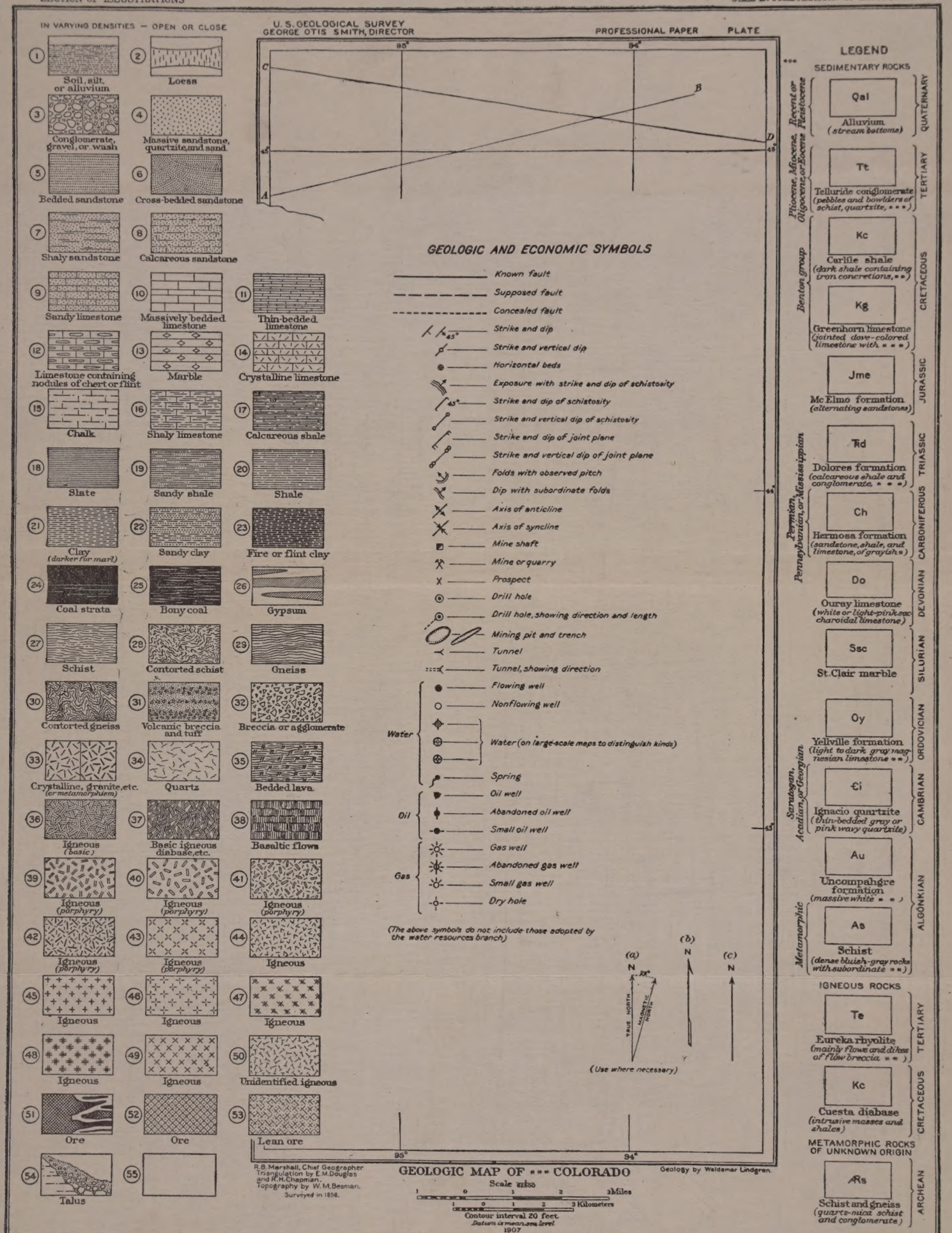


PLATE XIII.—Symbols used in the preparation of illustrations by the United States Geological Survey.

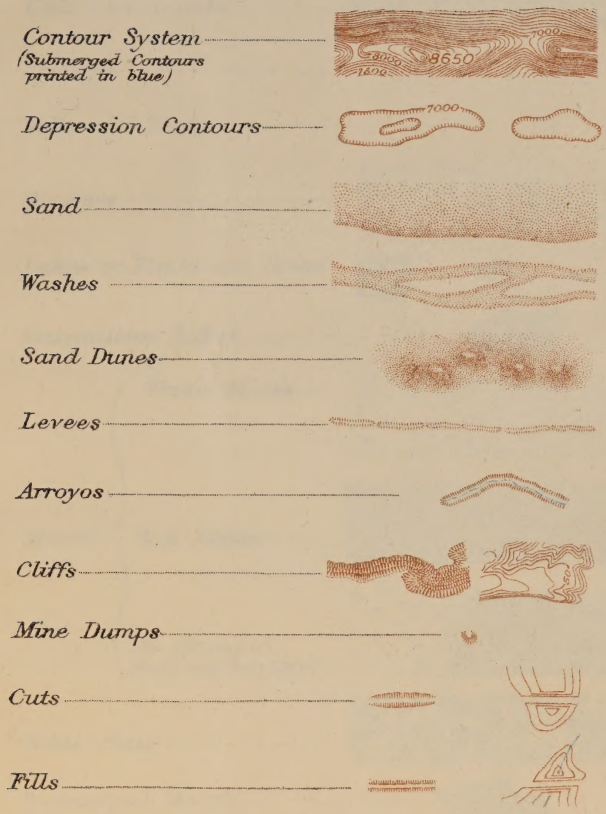


PLATE XIV.—CONVENTIONAL SIGNS OF THE UNITED STATES GEOLOGICAL SURVEY—HYPSOGRAPHY.

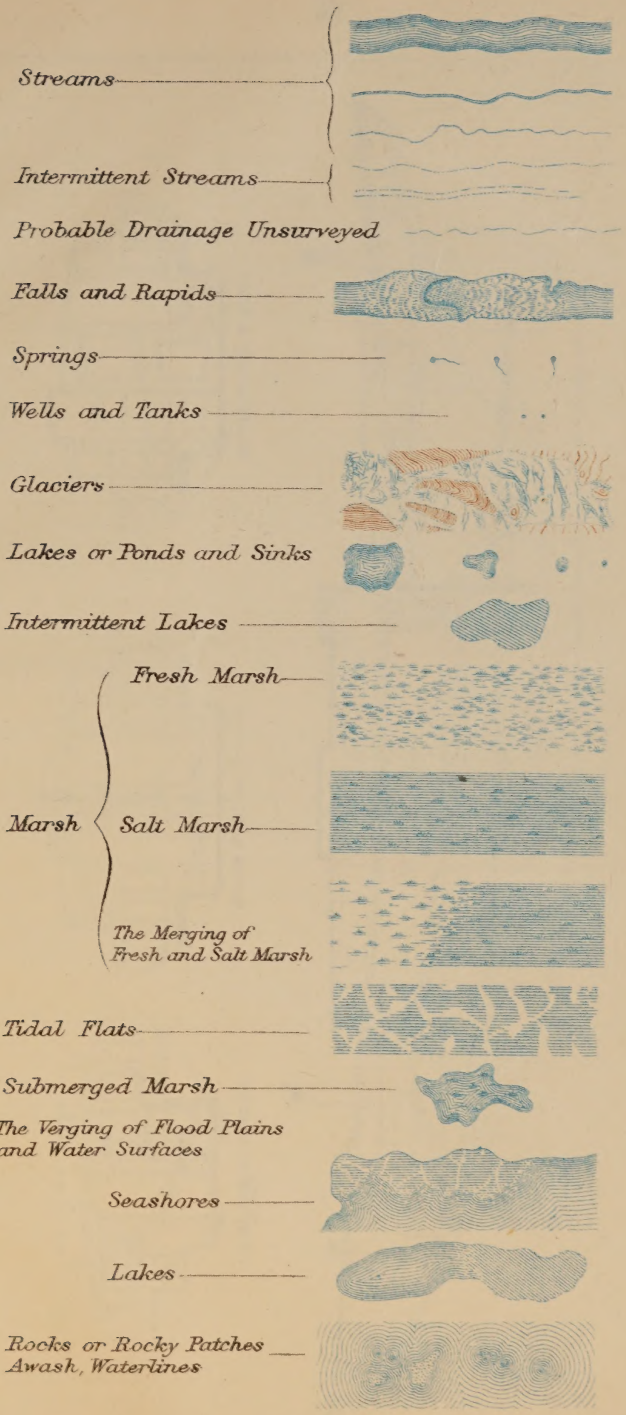


PLATE XV.—CONVENTIONAL SIGNS OF THE UNITED STATES GEOLOGICAL SURVEY—HYDROGRAPHY.

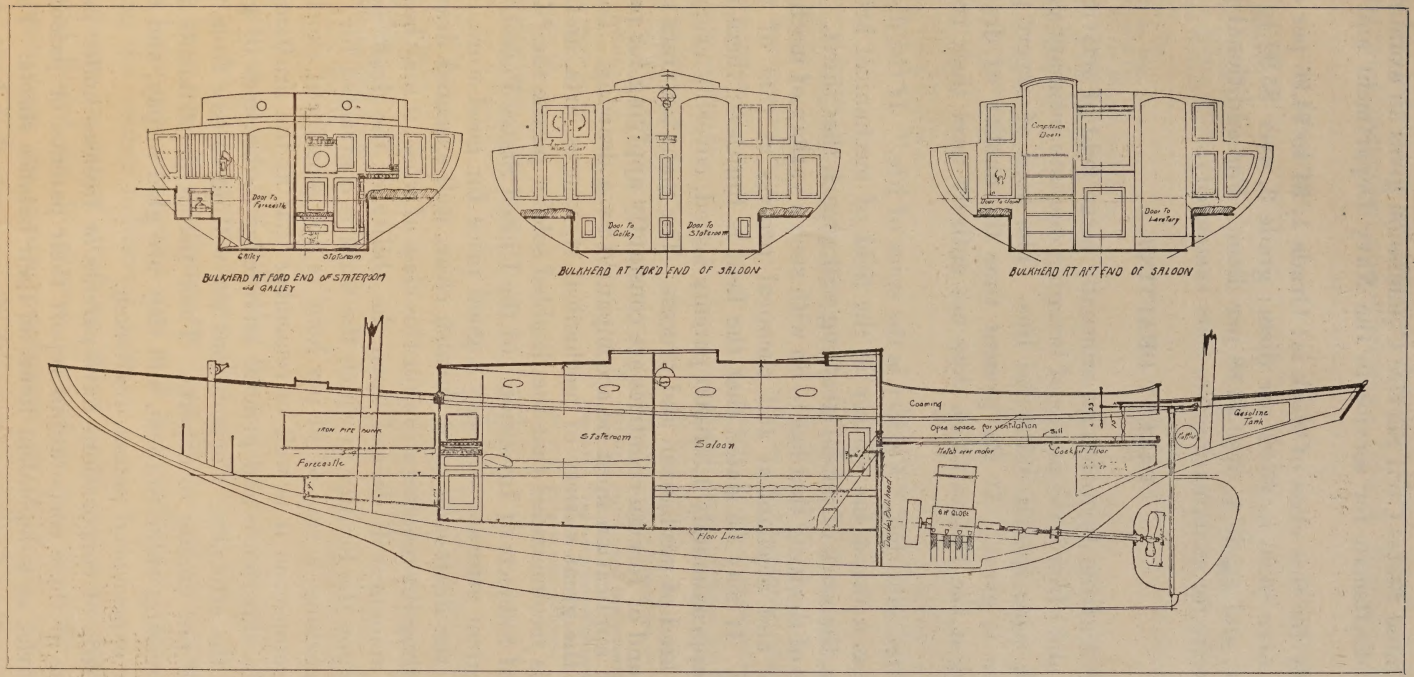


PLATE XVI.—Profile and cross section of a launch.

The United States Civil Service Commission gives an examination for ship draftsman for service in the Navy Department and navy yards.

The pay for this class of work is: Grade 1, $4 to $4.96 per diem; grade 2, over $4.96 to $5.92 per diem; grade 3, over $5.92 to $6.88 per diem; and grade 4, over $6.88 per diem. For additional information write for examination No. 1698 (amended).

PATENT DRAFTING.

Patent drafting furnishes an unusually large field of activity and interest, and often is the means of bringing one into intimate association with some special industrial line. The need of expert patent draftsmen is great. At the present time the quality of drawings presented at the Patent Office does not entirely meet their requirements.

It is often said that, "Variety is the spice of life." If the disabled soldier has a thirst for variety in the field of mechanical arts and processes, the work of patent drafting will quench that thirst. There is no line of drafting that has to do with such a variety of mechanical structure and mechanical and chemical process as that of patent drafting. It may be stated that the field is limitless; there are at present approximately 1,500,000 patents issued, covering every conceivable kind of mechanism and process. The manufacturers of this country and of foreign countries are constantly applying for patents, and each application must be accompanied by a drawing. To learn more of the great variety of mechanical structures, arts, and processes, it is recommended that the disabled soldier peruse the "Classification of Subjects of Invention" of the United States Patent Office.

The patent attorney will pay a good price for good work in this line, but the draftsman must furnish clear, well-executed drawings.

Regarding the remuneration for this class of work, it may be stated that its amount will depend upon the ability of the draftsman, as well as upon the locality in which the work is contracted for. Generally speaking, a rate of $1 per hour is not considered exorbitant. In this connection it is well to remember that as the draftsman increases in experience and general knowledge he becomes of greater value to the attorney. Corporations are willing to pay from $2,000 to $3,000 per annum to experts. Their patent departments are of ever-increasing value to them, and they are glad to pay, and to pay well, for experienced patent draftsmen.

Hundreds of corporations have patents or licenses under patents, and some of these corporations report their patents, or patents and trade-marks, as independent items on their balance sheets. The following is a list of corporations with the amounts they have charged

up to the patents in the manner specified below as given by Moody. (Patents—Commercial and otherwise. Geo. R. Simpson, page 4.)

Corporations.	Dollars.	Title of items.
Ajax Rubber Co	1	Patents.
American Brass Co	1,000	Do.
American Cyanamid Co	3,543,475	Licenses, patents, etc.
American Rolling Mill Co	1,350,000	Patents, licenses, etc.
American Wringer Co	100,000	Patents, trade-marks.
Avery Co	98,869	Patents.
Atlas Tack Co	1,493	Patents and trade-marks.
Bemis Bros. Bag. Co	3,998	Patent rights.
E. W. Bliss & Co	1,023,341	Do.
Boston Woven Hose & Rubber Co	1	Patents.
J. I. Case Threshing Machine Co	1,036,027	Patents, designs, devices, etc.
Casein Co. of America	4,555,168	Patents.
Dennison Mfg. Co	13,418	Patent rights.
Diamond Match Co	2,000,000	Do.
Draper Co	100,000	Patents, etc.
Electric Storage Battery Co	11,000,000	Patents, trade-marks, and agreements.
Emerson Phonograph Co	1,000,500	Patents.
Fairbanks & Co	3,142	Do.
Ford Motor Co	64,339	Do.
General Motors Co	413,500	Patents, agreements, etc.
Gillette Safety Razor Co	900,000	Trade-marks, patents, etc.
Goodyear Tire & Rubber Co	1	Patents, trade-marks, and designs.
Grey & Davis (Inc)	307,748	Trade-marks, patents, etc.
Hall Mfg. Co	238,282	Patents.
Hood Rubber Co	1,000	Do.
Ingersoll-Rand Co	683,000	Patents, etc.
International Rubber Co	15,142	Patents.
International Button-Hole Sewing Machine Co	325,301	Patents and machines on lease.
Jeffery Mfg. Co	193,856	Patents.
Keystone Steel & Wire Co	78,672	Patents, drawings, etc.
Lanston Monotype Machine Co	4,372,046	Rights, franchises, improvements, and patents.
Lee Tire & Rubber Co	400,800	Patents, trade-marks, etc.
Link-Belt Co	50,000	Patents.
Mergenthaler Linotype Co	4,000,000	Rights, privileges, and franchises.
Miller Rubber Co	125,000	Trade-marks and patents.
Ohmer Fare Register Co	925,000	Patents.
Packard Motor Car Co	1	Rights, franchises, etc.
Page Woven Wire Fence Co	1,000,000	Patents, franchises, etc.
Pennsylvania Salt Mfg. Co	5,275	Patents.
Plymouth Rubber Co	100,000	Patents and trade-marks.
Reece Button-Hole Machine Co	882,367	Patents.
Reading Hardware Co	500,000	Trade-marks and patents.
Sherwin-Williams Co	67	Patents and trade-marks.
St. Louis Car Co	507,915	Patents and patterns.
Standard Motor Construction Co	1,716,338	Patents.
T. H. Symington Co	1,102,667	Do.
Submarine Signal Co	1,263,394	Do.
Union Switch & Signal Co	1,025,725	Do.
United Shoe Machinery Co	400,000	Patent rights.
United Drug Co	9,974,213	Trade-marks, patents, and formulas.
U. S. Bobbin & Shuttle Co	2,482	Patents and patterns.
Utica Knitting Co	16,000	Patents.
Ward Baking Co	6,000,000	Patents and trade-marks.
Warren Bros	2,000,000	Patents.
Waltham Watch Co	4,502,000	Patent rights.
Westinghouse Elec. & Mfg. Co	4,852,648	Charters, franchises, patents, insurance.
Yale & Towne Mfg. Co	2,000,000	Patent rights and trade-marks.

A glance at this list will also show what a large field there is in general drafting, for the reason that all of these firms and corporations have need of draftsmen in their shops and workrooms; all of them have used draftsmen and will use draftsmen more than ever during the coming industrial wave.

A course in patent drafting given under the supervision of the Federal Board for Vocational Education will not only insure one who completes the course permanent employment, but will, it is

believed, be a means of developing capacity for taking up some special line of patent work, such as "specification writing," "searching," or, for that matter, "general patent practice."

Requirements.

The requirements for training are (*a*) knowledge of the principles of mechanical drawing, (*b*) elementary perspective drawing, (*c*) principles of shades and shadows, (*d*) elementary free-hand drawing. The subjects required for this course have been already treated to some extent in the preceding sections of this monograph.

In practice the patent draftsman is called upon to illustrate the inventor's device. The data furnished by him is varied in character; a model, sketch, or blue-print of the alleged invention, together with a description of the same is presented, and the draftsman is expected to thoroughly illustrate the same, selecting the necessary views, arranging them properly upon the sheet, shading them to clearly bring forth the structure, and applying the reference numerals in correspondence to the specification.

The drawings for the illustration of a mine-breathing apparatus are shown by Plates XVII to XXV. These drawings were made from a working model furnished by the inventor.

Figure 1, Plate XVII, is a diagrammatic illustration of the flow of oxygen and air through the apparatus and lungs. Figure 2, Plate XVIII, is a perspective view of the apparatus in position on the wearer ready for actual use. Figure 3, Plate XIX, is a front elevation. Figure 4, Plate XX, is a rear elevation. Figure 5, Plate XXI, is an elevation of the right side of the apparatus. Figure 6, Plate XXI, is a section on the line 6–6 of figure 4, the lower part of the apparatus being broken away. Figure 7, Plate XXII, is a horizontal section through the distensible breathing chamber and bellows on line 7–7 of figure 6. Figure 8, Plate XXII, is a vertical section on line 8–8 of figure 4. Figure 9, Plate XXII, is a section on line 9–9 of figure 8. Figure 10, Plate XXII, is a section on line 10–10 of figure 8. Figure 11, Plate XXII, is a longitudinal section of the admission valve. Figure 12, Plate XXII, is an elevation of the lever which opens the admission valve. Figure 13, Plate XXIII, is a vertical longitudinal section of the air purifying or regenerating chamber. Figure 14, Plate XXIII, is a horizontal longitudinal section of the purifying chamber on line 14–14 of figure 13. Figure 15, Plate XXIII, is a section on line 15–15 of figure 13. Figure 16, Plate XXIII, is a section on line 16–16 of figure 13. Figure 17, Plate XXIV, is a vertical section through the pressure regulator or reducing valve and tube leading to the pressure gauge. Figures 18 and 19, Plate XXIV, show sectional details of the toggle member 89. Figure 20, Plate XXIV, is a longitudinal section of the valve 93. Figure 21, Plate

XXIV, is a plan view of the rod 90. Figure 22, Plate XXV, is an elevation of the pressure gauge, the casing being removed. Figure 23, Plate XXV, is a section on line 23–23 of figure 22. Figure 24, Plate XXV, is an elevation of the front of the gauge. Figure 25, Plate XXV, is an elevation of the rear of the pressure gauge cap and casing. Figure 26, Plate XXVII, is a section of an alternate form of breathing chamber.

It will be noted that the parts of the device are shaded to clearly bring forth their contour. This drawing gives an excellent idea of the art of patent drafting and of mechanical illustration as required by the United States Patent Office. The application of shade lines and shading is well shown. The use of free-hand drawing in this class of work also is illustrated. The style of lettering used is called "stump writing." This drawing may be considered typical.

While the great bulk of patent drafting pertains to mechanical structure, the patent draftsman is also called upon to make drawings of designs and trade-marks. Briefly described, a design consists of the visual characteristics displayed by an object. Designs may be divided into two general types—one existent in the contour or outline of an object; the other in a decoration applied to the surface thereof.

The designs shown in Plates XXVI and XXVII are of casket ornaments. These drawings were made from models. Shading has been applied to bring out the contour. This is the class of work that illustrates the need for a knowledge of shades and shadows.

In figures 27 and 28 the drawings are of designs for brocade-silk fabric. The fabric itself was furnished, and the salient features of the design were drawn therefrom. Here we have an example of pen and ink rendering. It is seen that to do this class of work the draftsman must have had some experience in pen and ink drawing.

A trade-mark may generally be defined as a convenient manner of disclosing the commercial source or origin of goods that are sold in trade. Figures 29 to 31 show specimens of trade-marks. The drawings are generally made from the labels actually used upon the goods. At times the patent draftsman is called upon to design trade-marks, but this is an unusual occurrence; artists are usually employed to design them.

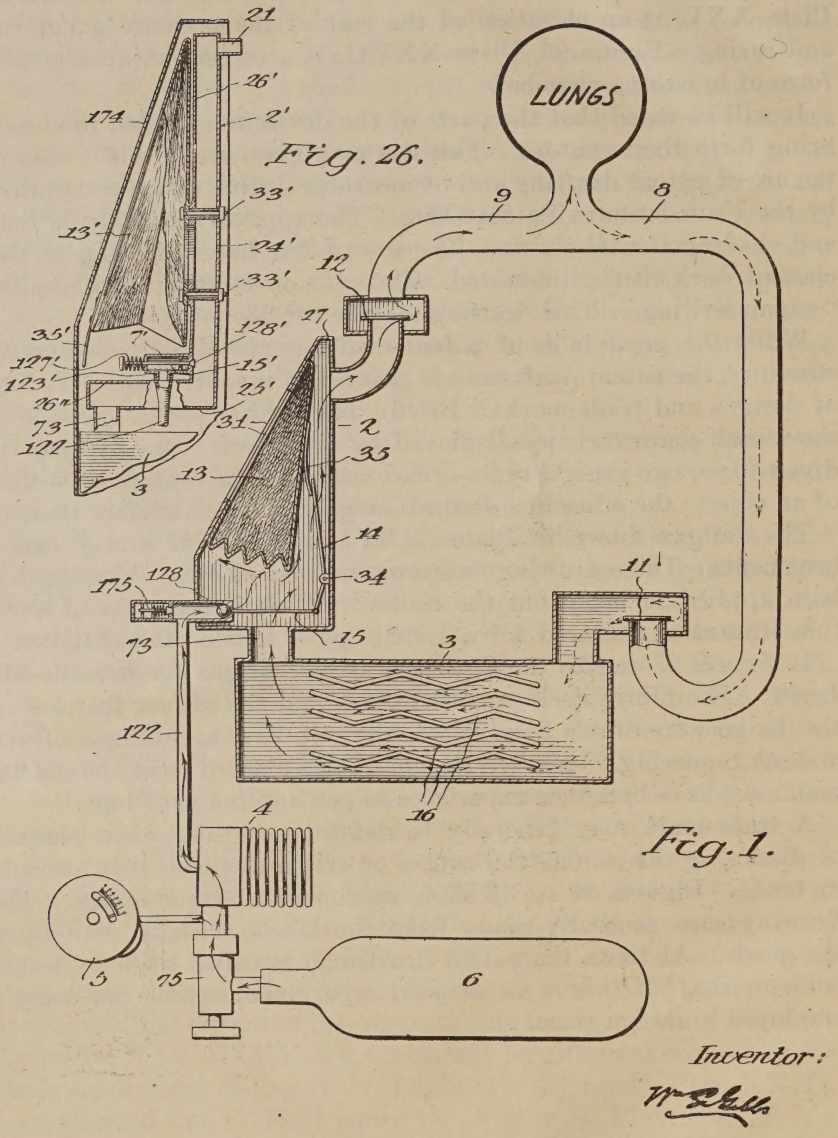


PLATE XVII.—Mine breathing apparatus. Patent Office drawing.

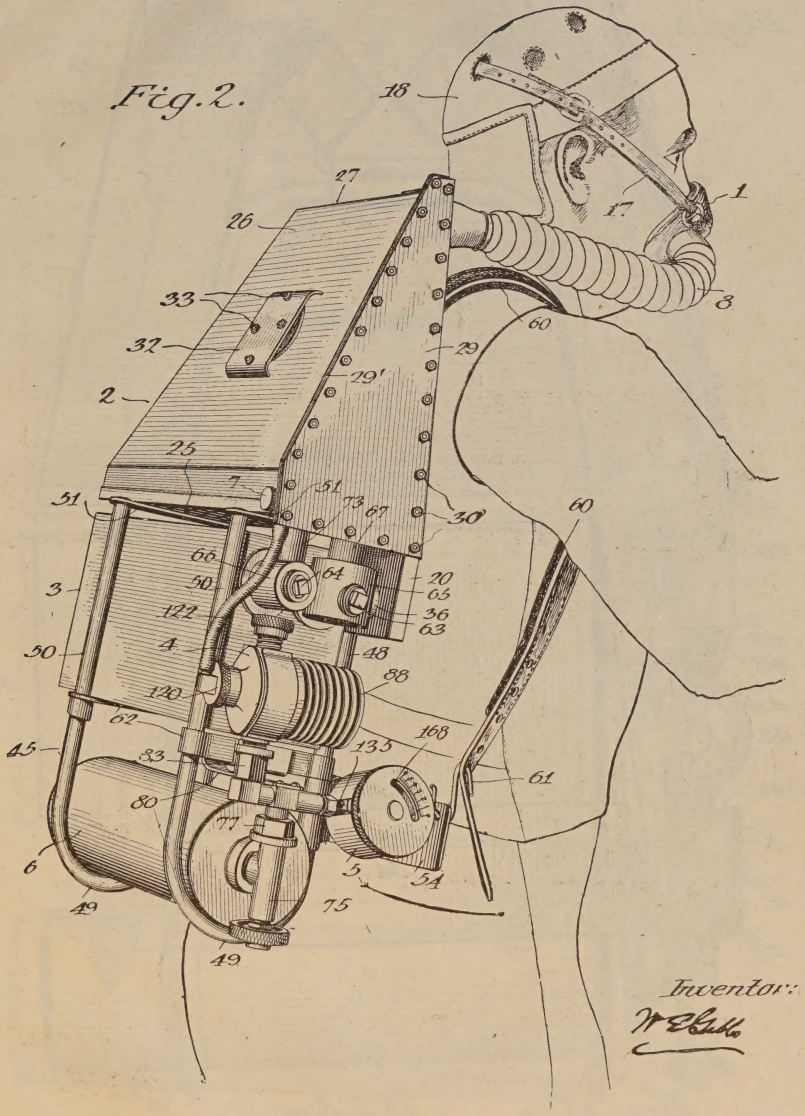


PLATE XVIII.—Mine breathing apparatus. Patent Office drawing.

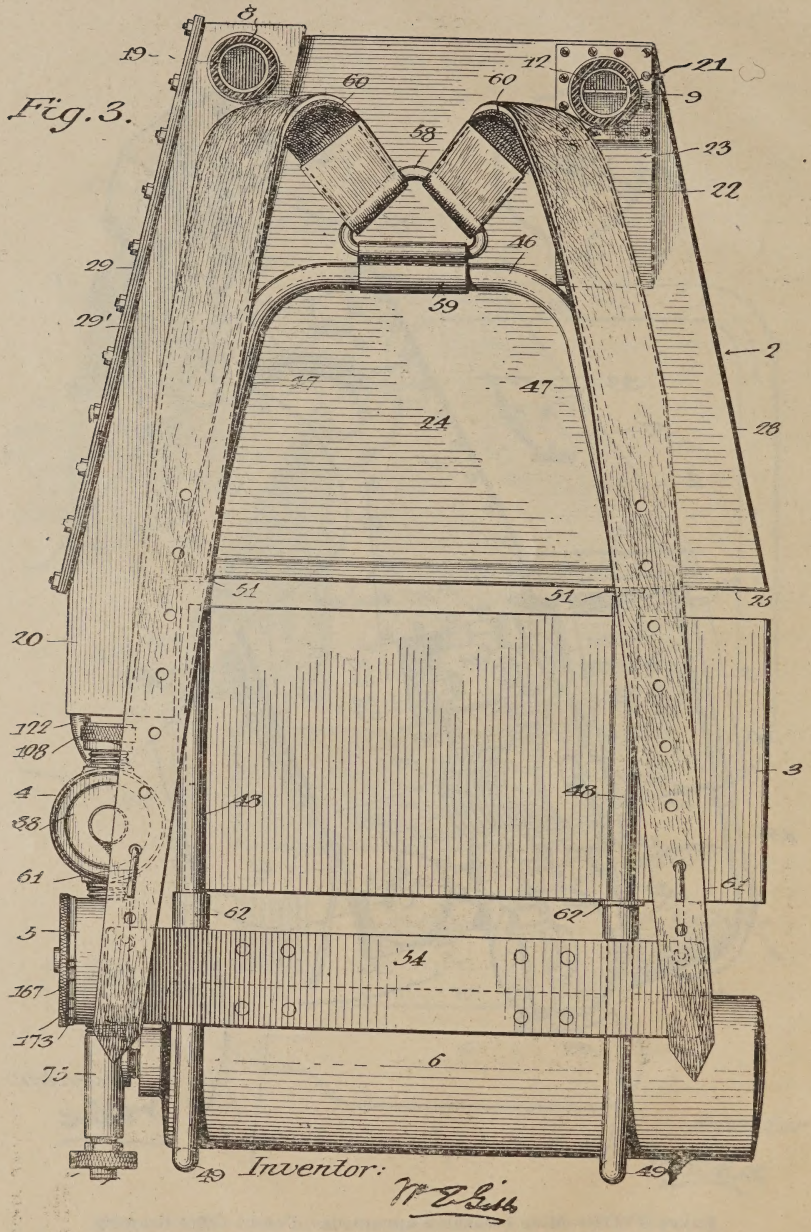


PLATE XIX.—Mine breathing apparatus. Patent Office drawing.

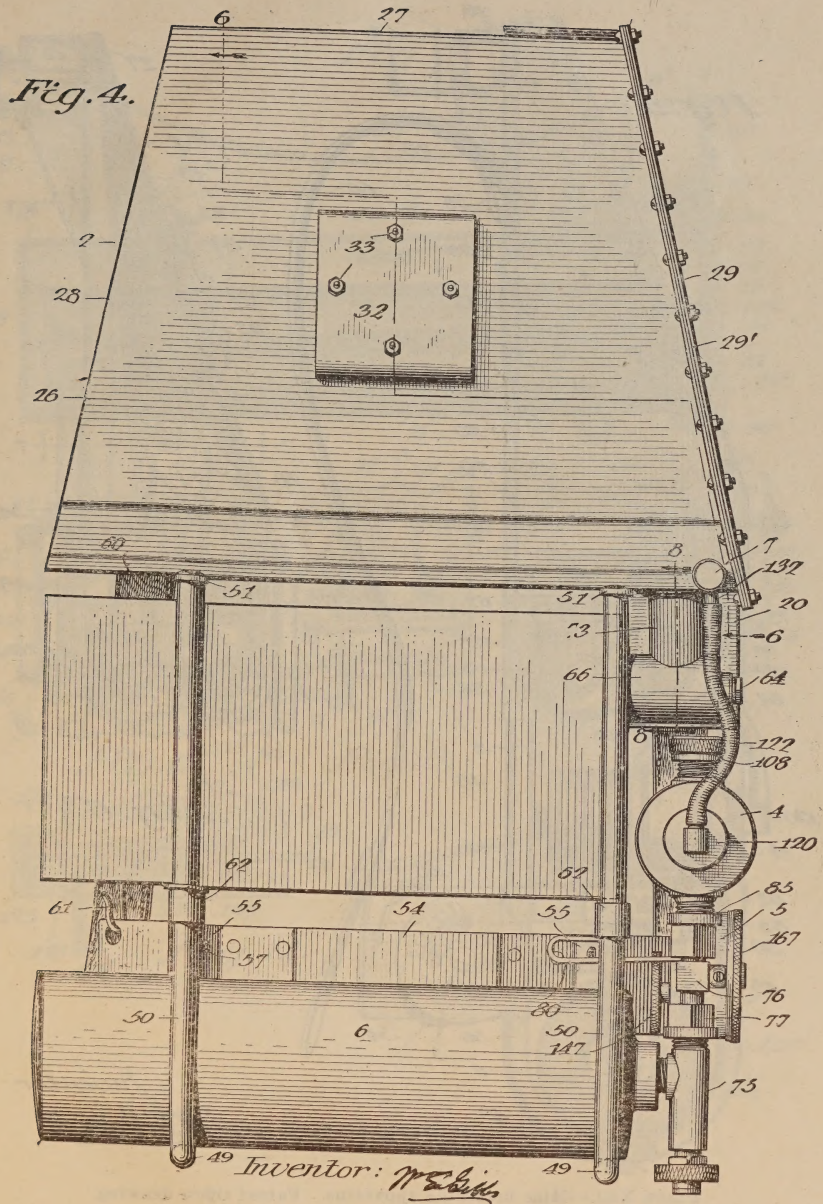
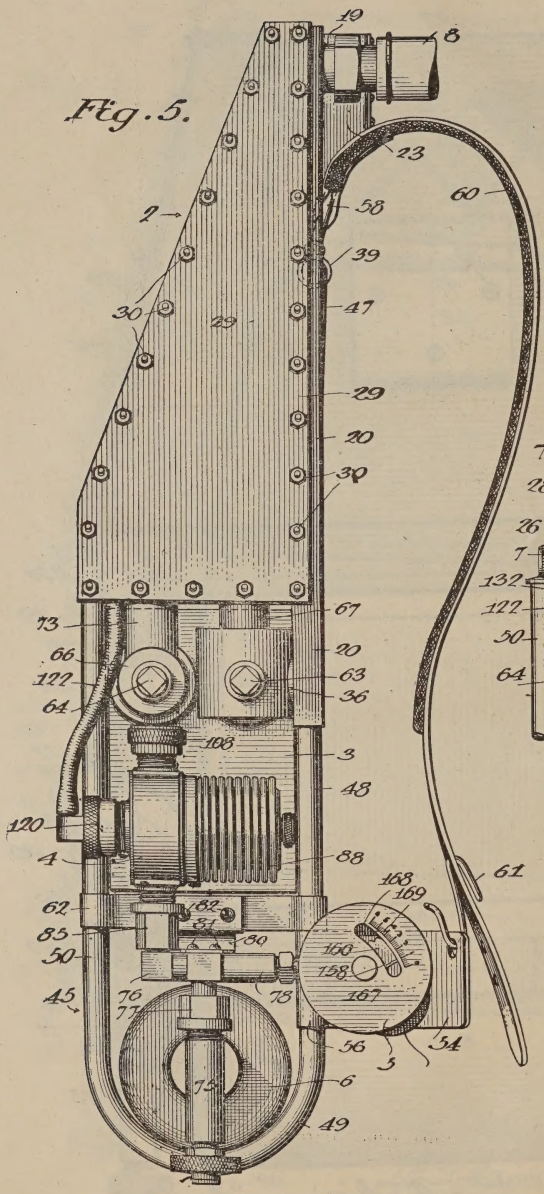


PLATE XX.—Mine breathing apparatus. Patent Office drawing.



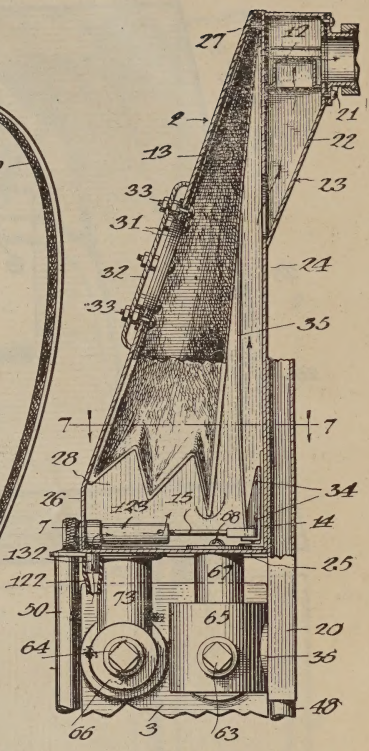
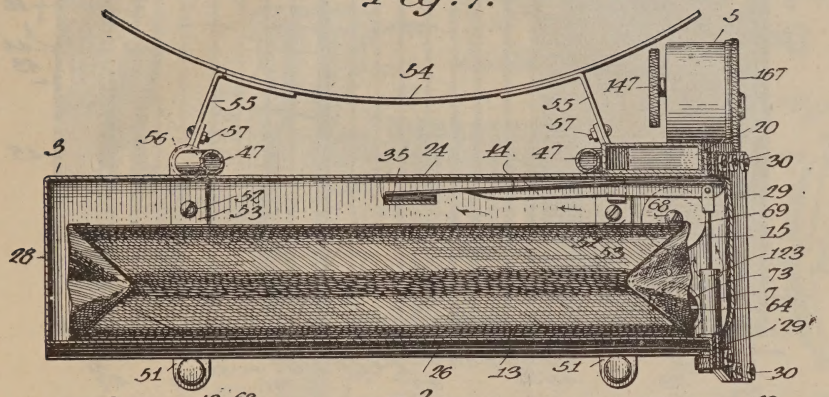


Fig. 6.

Inventor:
W. E. Gibbs

PLATE XXI.—Mine breathing apparatus. Patent Office drawing.

Fig. 7.



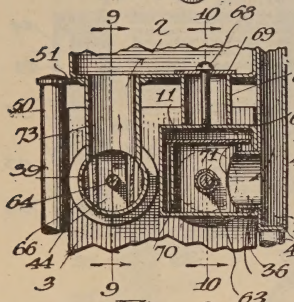


Fig. 8.

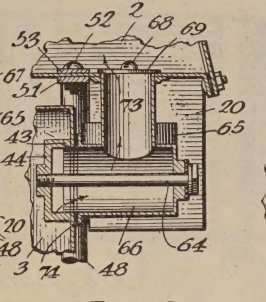


Fig. 9.

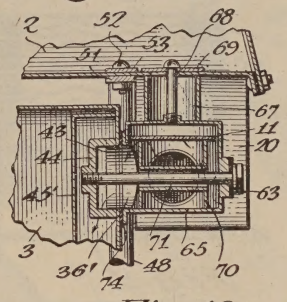


Fig. 10.

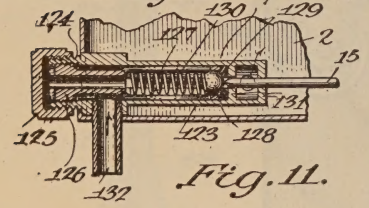


Fig. 11.

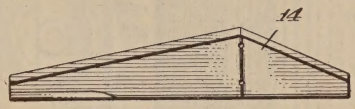


Fig. 12.

Inventor

PLATE XXII.—Mine breathing apparatus. Patent Office drawing.

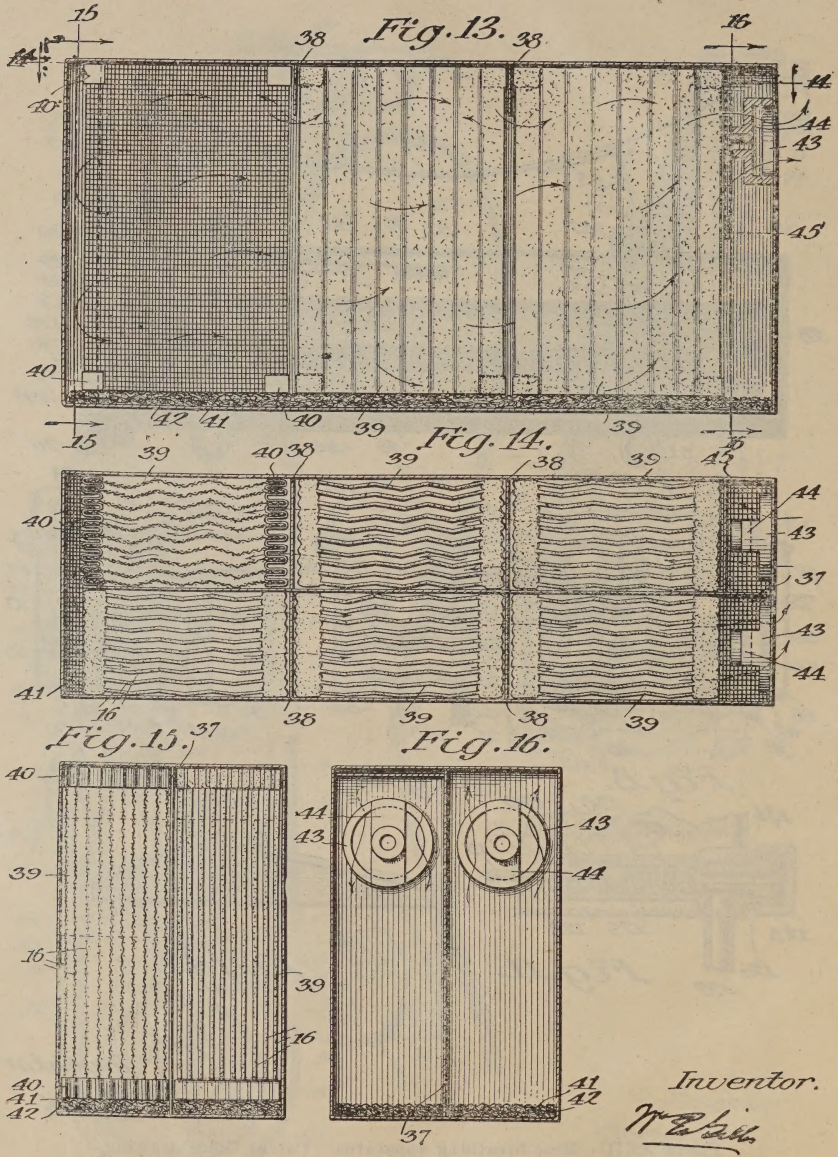


PLATE XXIII.—Mine breathing apparatus. Patent Office drawing.

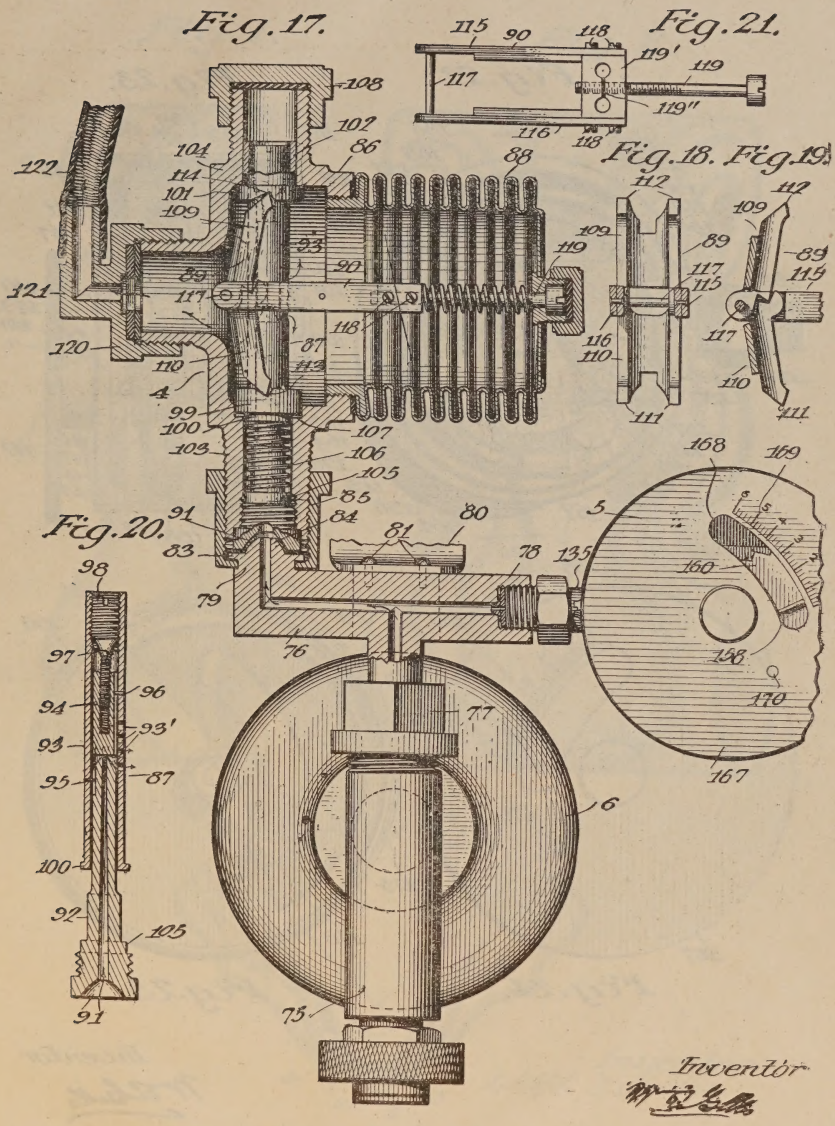
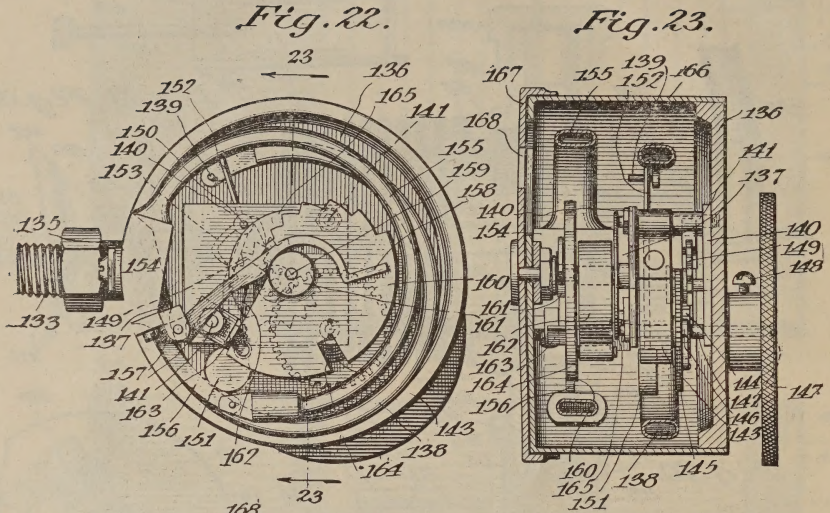


PLATE XXIV.—Mine breathing apparatus. Patent Office drawing.



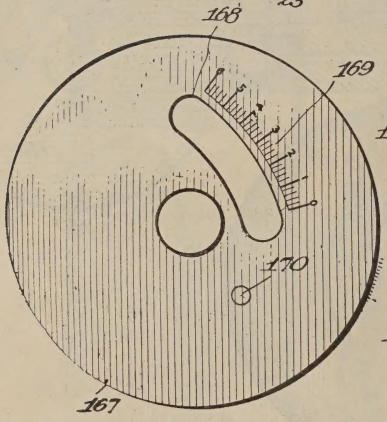


Fig. 24.

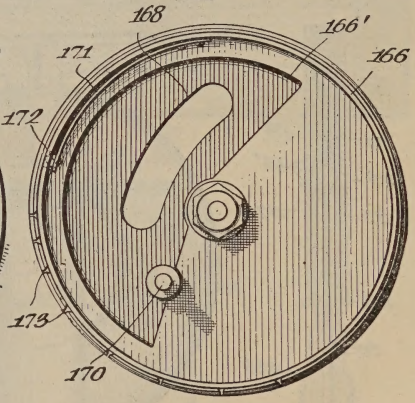


Fig. 25.

Inventor
W. E. Bibb

PLATE XXV.—Mine breathing apparatus. Patent Office drawing.

Fig. 1.

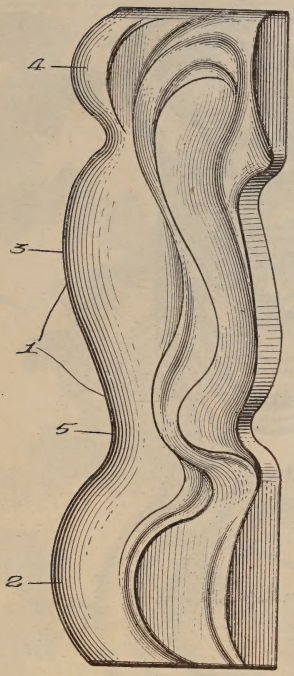


Fig. 2.

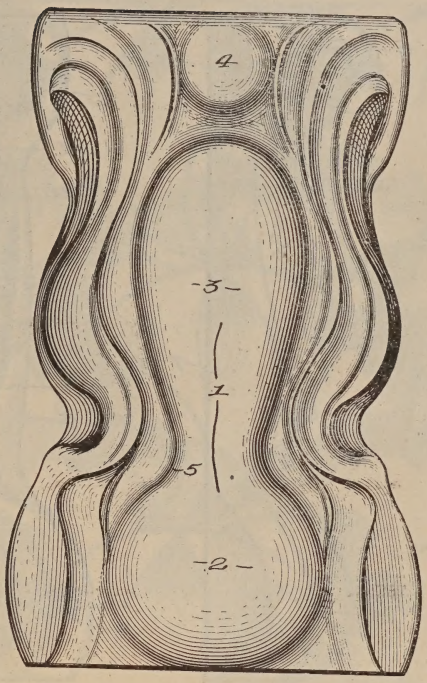
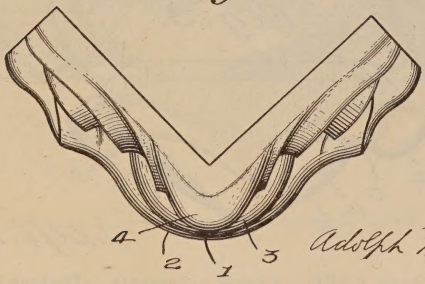


Fig. 3.



Inventor:
Adolph M Holstein

PLATE XXVI.—Casket ornaments. (Designs.)

Fig. 1.

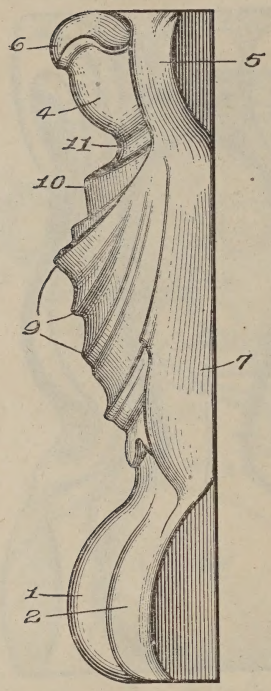


Fig. 2.

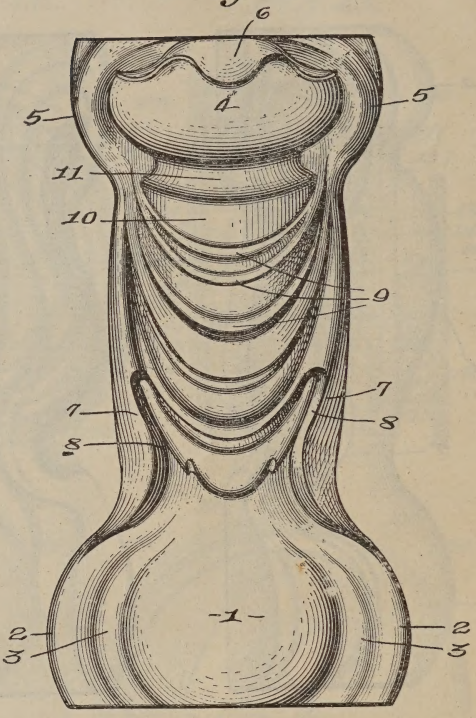
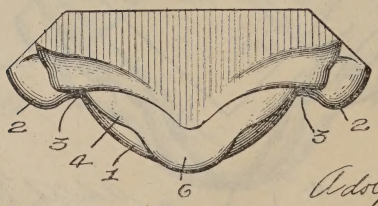


Fig. 3.



Inventor
Adolph M. Hastens

PLATE XXVII.—Casket ornaments. (Designs.)

FIGURE 27.—Designs of brocade-silk fabric.

Inventor:
J.H.Bunting

FIGURE 28.—Designs of brocade-silk fabric.

FIGURE 29.—Trade-mark.

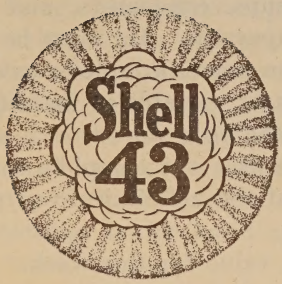


FIGURE 30.—Trade-mark.

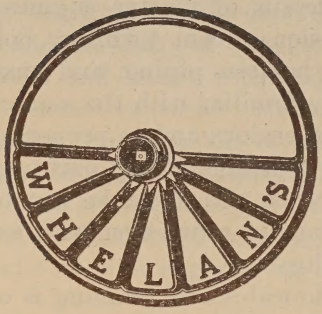


FIGURE 31.—Trade-mark.

COMMERCIAL AND OTHER DRAFTING.

Below will be found a brief summary of additional drafting activities. Let it be remembered that mechanical drafting furnishes the basis for all of them.

Commercial Drafting.

The commercial draftsman should be able to do general all-round drafting such as may be required by any commercial firm or institution. This work may include laying out location of buildings, drawing plans of arrangements in offices, large rooms, and factories, and preparing all kinds of forms, records, and charts.

He must be skilled in the use of all drafting instruments required for this kind of work, such as pens, compasses, dividers, T squares, straight-edges, triangles, and scales, and in the use of various paints and washes for coloring drawings.

Preferably he should have had a high-school training or the equivalent.

Marine Engine and Auxiliary Drafting.

The duties of the marine engine and auxiliary draftsman are to prepare assembly and detail drawings of marine engines and auxiliary ship equipment.

For this work the draftsman must be a thoroughly experienced mechanical draftsman, with special knowledge of the general design and details of marine engines—either single, compound, or triple expansion—steam turbines, boilers, pumps, condensers, and feed-water heaters, piping, and auxiliary apparatus. He must be thoroughly familiar with the materials of construction; able to calculate the dimensions and to proportion the parts; capable of making sectional drawings of any part or parts of the main power or auxiliary apparatus. He must be capable of turning out complete finished drawings in connection with any part of the mechanical equipment of a ship.

Technical-school training is of special value for this work.

Mine Drafting.

The duties of the mine draftsman are to draw to scale machine and structural designs worked out by the mining engineer or the mine superintendent; to make sketches and blue prints of all mine workings, both plane and sectional; and to plot survey notes turned in by the mine surveyor.

The mine draftsman must be, first, a mechanical draftsman; in addition, he must be also a good letterer in Roman and block type of letter; he must be familiar with mining machinery and mine terms; and must have a knowledge of topographic and map work. He should have good health and good eyesight. He should have had

experience in a drafting room, making drawings under the direction of a mining engineer or a superintendent, and should have had considerable independent experience.

Technical high-school or college training is desirable.

Railroad-Shop Drafting.

The duties of the railroad-shop draftsman are to make drawings for locomotives, for all general machine parts, and for railway-car equipment.

He must have a thorough knowledge of strength of materials and of their use as applied to rolling stock; he must be experienced in the design of locomotive parts; must be familiar with shop practices, including machine tool work, pattern, and foundry work; must be a thoroughly skilled general designer and draftsman; and must be familiar with railroad practice. He should have had experience in machine design and drafting in railroad shops.

High-school training or the equivalent and preferably some technical training is desirable.

Reinforced Concrete Drafting.

The duties of the reinforced-concrete draftsman are the designing and detailing of all classes of work involving reinforced and concrete construction.

He must be an experienced draftsman and designer of various types of concrete buildings, arches, dams, abutments, piers, conduits, and retaining walls, either mass or reinforced. He should know something of the physical properties and chemistry of cement, and of the various kinds and grades of sands and stones with respect to relative adaptability for use in reinforced concrete. He must be capable of calculating proportions, size, and spacing of reinforcing and of the placing of the same, and of calculating quantities and costs; and he must be able to design in detail, forms and framing for concrete work of all sorts. He should have had experience on general contracting, bridge building, hydraulic or civil engineering or railroad work.

He should be a graduate of a technical school.

Structural Drafting.

The duties of the structural draftsman are the designing and detailing of plans involved in any construction employing structural steel.

He must be a thoroughly competent and experienced structural draftsman for bridges and buildings; must have a thorough knowledge of the design of bridge trusses, plate girders, roof trusses, trestle bridges, columns, and such steel as would enter into viaducts; and must, also, be skilled in structural design and fabrication of buildings. He must have some knowledge of building requirements as

regards reinforced-concrete work, arches, abutments, piers, and retaining walls, including a knowledge of material and erecting equipment. He must be competent to calculate quantities, and prepare estimates of materials and costs. He should have had experience in general structural engineering, bridge construction, railroad or architectural building work.

Preferably he should be a technical-school graduate.

LETTERING.

In all courses on drafting the subject of lettering is taught. The style of lettering may and does vary, but a knowledge of the general subject must be had.

The Gothic style, an American term applied to letters whose form is that of the Roman, but whose limbs are all of the same width, is the style most used. Instruction on the proportion and spacing of both capital and small letters of this style will be given, as well as of the hair-line Gothic. The latter style is particularly applicable to free-hand work and the making of notes. While the Roman is the handsomest and the most dignified of all letters, yet the Gothic, because of its simplicity, is more generally used. Too much stress can not be laid upon the advisability of the student mastering this subject. Persistent practice is necessary to its accomplishment, but the results will repay one for the reason that well executed lettering gives quality to the finished work. The inclined and vertical Gothic and hair-line Gothic styles are the two most important; let them be studied faithfully. The antique, hair-line antique, and block styles are also used in lettering mechanical drawings. (See Plates XXVIII to XXX.)

The styles of lettering used by architectural draftsmen are quite varied. For titles and explanatory notes the Gothic and hair-line Gothic are used. The object, generally speaking, is to give an artistic appearance to the drawing. Roman letters are also used and much attention has been given to the study of their form and spacing. (See Plate XXXI.)

Certain classical lettering based upon the Roman and Gothic styles is used for architectural inscriptions. It may be said that these two styles and their modifications furnish a basis for most architectural lettering. The reader is referred to "Proportion and Spacing of Roman Letters," as ascertained from the best examples by William Welch, draftsman, Appendix No. 4, Report for 1900, Coast and Geodetic Survey.

For topographic and hydrographic drafting the Roman and Italic lettering is used, as well as stump writing. (See Plates XXIX and XXXI.)

The Patent Office requires the use of italics and stump writing. (See Plate XXXI.)

If the student wishes, at a later date, to take up this subject more exhaustively as a matter of interest and development, he will find a list of works relative to it under the head of Bibliography at the end of this monograph.

UNITED STATES CIVIL SERVICE EXAMINATION FOR DRAFTSMAN.

Following is a list of examinations given by the United States Civil Service Commission for draftsman:

Copyist draftsman, examination No. 350. This examination is for positions in the office of the Chief of Ordnance of the War Department. The salary paid is $1,100 per annum.

Draftsman, Bureau of Yards and Docks, Navy Department, examination No. 316. This examination is to fill vacancies in the Navy Department for duty at Washington, D. C., at any of the navy yards, or other stations in the naval establishment of the United States. The salaries paid range from $3.04 to $7.04 per diem.

Electrical draftsman, Bureau of Steam Engineering, Navy Department, examination No. 299. This examination is given to fill vacancies in the Bureau of Steam Engineering and Navy Department, for duty at Washington, D. C., or at any navy yard or naval establishment of the United States. The salaries are, for grade 1, $4 to $4.96 per diem; grade 2, $5.44 to $6.40 per diem.

Mechanical draftsman, office of the Chief of Ordnance, War Department, examination No. 242. The salaries are as follows: Grade 1, $800 to $1,400 per annum; grade 2, over $1,400 to $1,800 per annum; grade 3, over $1,800 to $2,500 per annum.

CONSTRUCTION OF GOTHIC CAPITALS
A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z &
Construction of Gothic Small
a b c d e f g h i j k l m n o p
q r s t u v w x y z

PLATE XXVIII.—Gothic letters.

HAIRLINE GOTHIC

ABCDEFGHIJKLMNOPQRSTUVWXYZ&

abcdefghijklmnopqrstuvwxyz

INCLINED HAIRLINE GOTHIC

ABCDEFGHIJKLMNOPQRSTUVWXYZ&

abcdefghijklmnopqrstuvwxyz

HAIRLINE ANTIQUE

ABCDEFGHIJKLMNOPQRSTUVWXYZ

ANTIQUE

ABCDEFGHIJKLMNOPQRSTUVWXYZ

PLATE XXIX.—Hair-line, italic, and antique lettering.

BLOCK

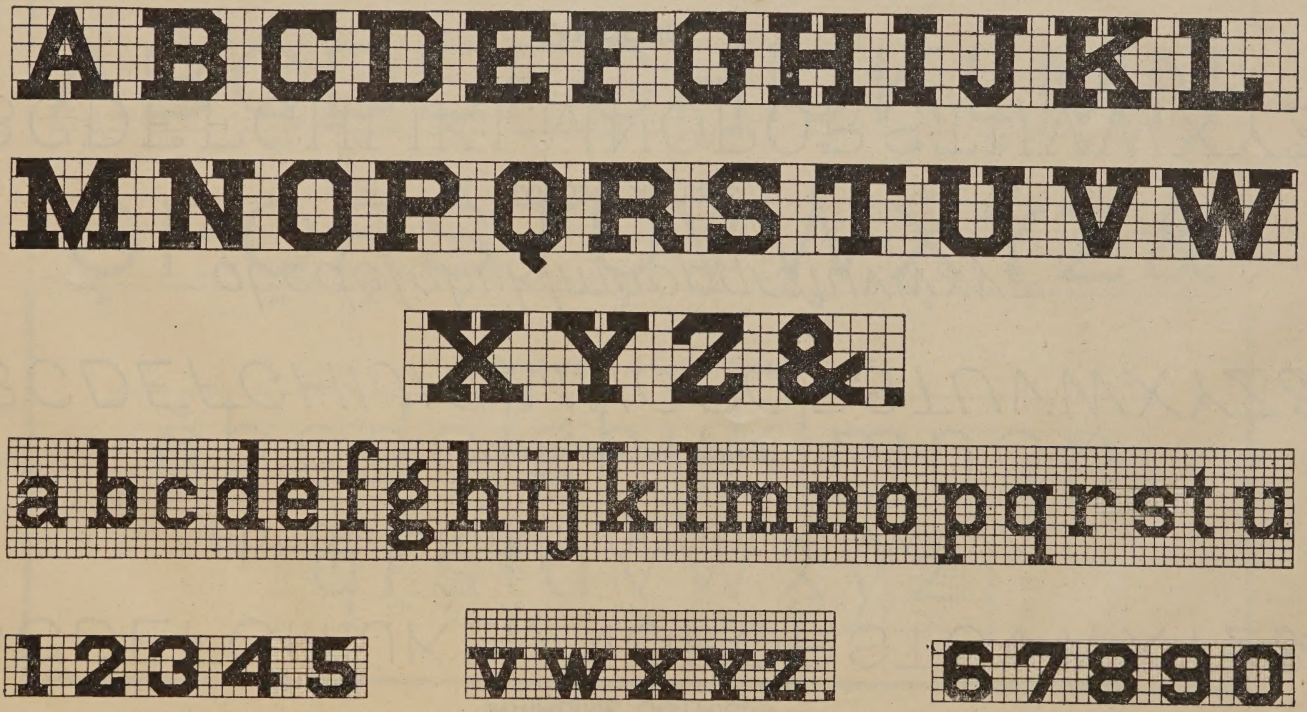


PLATE XXX.—Block letters.

LETTERING

CIVIL DIVISIONS

States, Counties, Townships, Land Grants, Reservations, Capitals, Cities, Towns, Villages, Localities.

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz

HYDROGRAPHY

Oceans, Seas, Gulfs, Bays, Lakes, Ponds, Rivers, Creeks, Brooks, Springs, Falls, Rapids, Marshes, Glaciers.

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz

PLATE XXXI.—Roman, italic, and stump writing.

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Carmichael, A. W. Shipbuilding for beginners. Assistant naval constructor, United States Navy.

Aids to employment managers and interviewers on shipyard occupations with description of such occupations. Special bulletin.

Handbook on employment management in the shipyard. Dealing with modern methods and practices of employment management. Bulletin II.

Elements of blue-print reading for steel-ship construction—Course No. 2s.

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Bulletins published by the United States Department of Labor:

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District No. 5.—North Carolina, South Carolina, Georgia, Florida, and Tennessee. Office: 823 Forsyth Building, Atlanta, Ga.

District No. 6.—Alabama, Mississippi, and Louisiana. Office: 412–432 Maison Blanche Annex, New Orleans, La.

District No. 7.—Ohio, Indiana, and Kentucky. Office: 1212–1214 Mercantile Library Building, Cincinnati, Ohio. Branch office: Home Service Section, American Red Cross, Park Building, Cleveland, Ohio.

District No. 8.—Michigan, Illinois, and Wisconsin. Office: 1600 The Westminster, 110 South Dearborn Street, Chicago, Ill. Branch office: 807 Owen Building, Detroit, Mich.

District No. 9.—Iowa, Nebraska, Kansas, and Missouri. Office: 815–824 Chemical Building, St. Louis, Mo. Branch office: 413 Massachusetts Building, Kansas City, Mo.

District No. 10.—Minnesota, North Dakota, and South Dakota. Office: Room 742 Metropolitan Bank Building, Minneapolis, Minn.

District No. 11.—Wyoming, Colorado, New Mexico, and Utah. Office: Room 400 Mercantile Building, Denver, Colo.

District No. 12.—California, Nevada, and Arizona. Office: Room 997 Monadnock Building, San Francisco, Calif.

District No. 13.—Montana, Idaho, Oregon, and Washington. Office: Room 539 Central Building, Seattle, Wash.

District No. 14.—Arkansas, Oklahoma, and Texas. Office: 810 Western Indemnity Building, 1000 Main Street, Dallas, Tex.